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WHAT'S AHEAD IN BUSINESS FOR 1928

IT IS only natural at this time of the year that every non-metallic mineral producer should hesitate long enough to take mental stock of what has gone before and attempt to envision the obstacles or subventions of the ensuing twelve months. And in exercising introspection it is difficult to resist the adventure of prophecy. The numberless possibilities for error only lend zest to the lure of prognostication. And, for that matter, one might quite as well gratify his adventurous spirit, for in this year, of all years, one man's guess is as good as another's.

At no time since the close of the war has there been more confusion of thought with respect to what is ahead in business. Economists whose batting averages have hitherto been high, freely admit themselves to be at a total loss to satisfactorily predetermine long range business. Several of the more eminent have reversed their conclusions time and again during the past twelve months.

All this is a result of failure on the part of business economists to develop new means for predetermination in order that they might keep in step with advanced business, plus everyone's failure to recognize the importance of factors that were nonexistent ten years ago. We lament the trend toward hand-to-mouth buying, for instance, yet completely overlook the fact that such a development is the inevitable result of high speed transportation. When transportation of goods was effected by slow moving boats and workmen's wages were paid semi-annually, dealers and wholesalers perforce carried large stocks. But when we transport our materials in 80 ton cars and 10 ton motor trucks traveling at high speed, then cut four days from the delivery time of orders by means of air mail or telegraphic codes, we should naturally expect the distributors' stocks to dwindle.

In our failure therefore to develop business economics into a science that will accurately interpret the true meaning of current figures and existing trends, it is anybody's guess as to what is coming. Those inclined to be sanguine will say: Car loadings have reached new and high levels this year; our holiday trade was the equal if not the better of last year; wholesale prices show strengthening tendencies; stocks of unsold goods, carried on borrowed money are low; check payments indicate a remarkable maintenance in trade volume; violent contractions in credit are highly improbable; labor troubles are at their lowest point since the war; while not the best of all time the agricultural condition is generally satisfactory; good health is being enjoyed by both the automotive and building construction industries, highway and public works projects are more extensive than ever before; commercial failures during 1926 hit a low mark; recent industrial mergers are a stabilizing influence; the Coolidge policies which were distinctly friendly to Business, will continue throughout the year and probably much longer; etc., etc.

Now up jumps the pessimist impatient to say that next year will be a Presidential year with its usual uncertainties; that the foreign situation clearly indicates keener, more aggressive competition; that the great steel trusts of Europe will slice our profits from exports; that our enlarged manufacturing capacity will whet the already keen competition and turn commodity prices downward; that neither payrolls nor employment figures equal those of one year ago; that agitation for unsound farm relief legislation will break our treasury surplus; that the wage curve has reached its peak and will presently start downward thus creating expensive labor disturbances; that railroad rolling stock orders cannot be so large as last year; that per capita electric power consumption has turned downward for the first time in history; that real estate transfers are about seven per cent off; etc., etc.

Two Dangerous Factors

The foregoing is enough to make one dizzy, yet such a recital of facts does not misrepresent in any way the "picture" for 1928 nor afford a possibility for "colored" conclusions. From them (and the arguments of both sides could be continued almost without end) we see this to be a period of confusion if not actual uncertainty.

In the "pessimistic" list there are two factors however, that warrant discussion. One needs refutation — the other consideration. Both are dangerous in that each holds potentialities for serious harm.

It will be remembered the pessimist said that 1928 would be a Presidential year and therefore attended with uncertainties. Let's spike that idea right now. That 1928 will be a Presidential year we all know, but to believe that the national election will affect business detrimentally is putting

belief in sheer bunk. With two exceptions, our national election has never affected general business one way or the other and it will not this year. Business during 1928 may be below normal. If so, it will not be because a President is to be elected. It may be a year of real prosperity—but not because it is a year of national election.

Excepting only the reactionary 1920, there have been six presidential years since 1880 when business was above normal and five presidential years when business was below normal. In all these years, except 1896, the business trend continued upward or downward unaffected by the period of elections.

In 1880 business was approximately 10% above normal.

In 1884 business started 10% below normal and continued to recede until it reached 20% by the middle of 1885.

In 1888 business was 8% above normal.

In 1892 business was 10% above normal.

In 1896 business was 12% below normal.

In 1900 business was 5% below normal.

In 1904 business was 2% below normal.

In 1908 business was 3% below normal.

In 1912 business was 6% above normal.

In 1916 business was 15% above normal.

In 1920 business was reactionary—not comparable.

In 1924 business was 18% above normal.

Five lean years—six fat years—one reactionary year. It would seem that the conviction that a presidential year means poor business is a myth.

These figures are given, and this issue with a hoary old fallacy is taken, because much harm may be done by repeating the ostrich-head-in-the-sand myth regarding election effects. A single influential industrialist or a series of only a half dozen cancellations can start an utterly needless depression. Surely we have arrived at a time where myths cannot effect business depressions.

The second dangerous factor to be spoken of here is the present day tendency to permit the unreasonable climbs of stock prices. Several declines in security values invariably have bad effects on business. Plentiful money may be used to boom a market but only satisfactory earnings can keep prices up over a protracted period. Established dividends are now on a basis so liberal as to immediately reflect any sharp decline in earnings. This is a reason sufficient unto itself to warrant closer attention to current earnings than to gold reserves or surpluses.

Earnings Must Be Paramount Consideration

The National Industrial Conference Board has repeatedly assured us that less than half the manufacturers of this country ever make one cent of profit and that not more than 10 per cent of them know what are their production costs. Startling statements when made by an organization that in no way leans toward the chimerical. Furthermore, as long ago as October, 1924, this somebody predicted a disturbing shortage of trained executives by the year 1935. Indeed, is not this prediction already meeting with fulfillment if only by reason of the large number of mergers that have been consummated during recent years? To entertain the combination of companies is not necessarily an indictment on the management being absorbed, but it must be self-evident that the company making a good profit and possessing a healthy prospective future is less likely to merge with another (except as the dominant party to the transaction) than the "weak sisters" who might welcome such combination in the interest of dividends.

In a keenly competitive period, such as 1928, and in a period outstandingly characterized by the rapid succession of radical developments which have a profound effect on all industry, such as the ensuing decade, the exercise of vision and aggressive action plus constant watchfulness over net earnings are prime essentials to success. Constructive advertising and effective sales promotion will do more than anything else to meet and overcome present day competition, while the maintenance of net earnings and the building of cash reserves is a matter of internal adjustment, conservative dividend policies, and a willingness to scrap either machinery or method in favor of that which will serve more efficiently.

The problems of tomorrow will be the problems of yesterday in aggravated form. It remains for industry to delete speculative tendencies and go forward, slowly and surely, on first principles.

IMMIGRATION ENLARGES POPULATION

THE population of the United States was increased by approximately 266,809 alien men, women and children as a net result of immigration during the fiscal year 1927, according to preliminary data from the U. S. Immigration Bureau. This figure represents the difference between the number of aliens admitted and those who departed. Aliens legally admitted numbered 335,175 in 1927 against 68,366 who imigrated from the United States.

The net result of immigration in 1927 was greater than in 1926 when the excess of immigrants over emigrants was 227,496 persons.

Population gains of the United States from immigration were highest in 1924 when the net increase was 630,107 persons. The 1921 net gain was also high, totaling 557,510 persons.

The net gains for the last eight years show the results of the Immigration Restriction law which limits the numbers of aliens who may be admitted each year from all foreign countries except those on the North American Continent. On citizens from Mexico and Canada there is no restriction.

RECENT RESEARCHES IN PORTLAND CEMENT

By Roy M. Green
Manager, Western Laboratories

THROUGH a long period of years experience has shown that the most desirable Portland cement concrete pavement bases have been constructed of lean concrete, that is concrete of a relatively low compressive strength, and these bases have always been constructed without expansion or center joints and also without the use of metal reinforcing. Regardless of the satisfactory performance of such bases, however, there is a growing tendency to increase the compressive strength of the concrete used for this purpose and in some instances there has been inserted into the base either expansion or center joints and in still other cases reinforcing has been required.

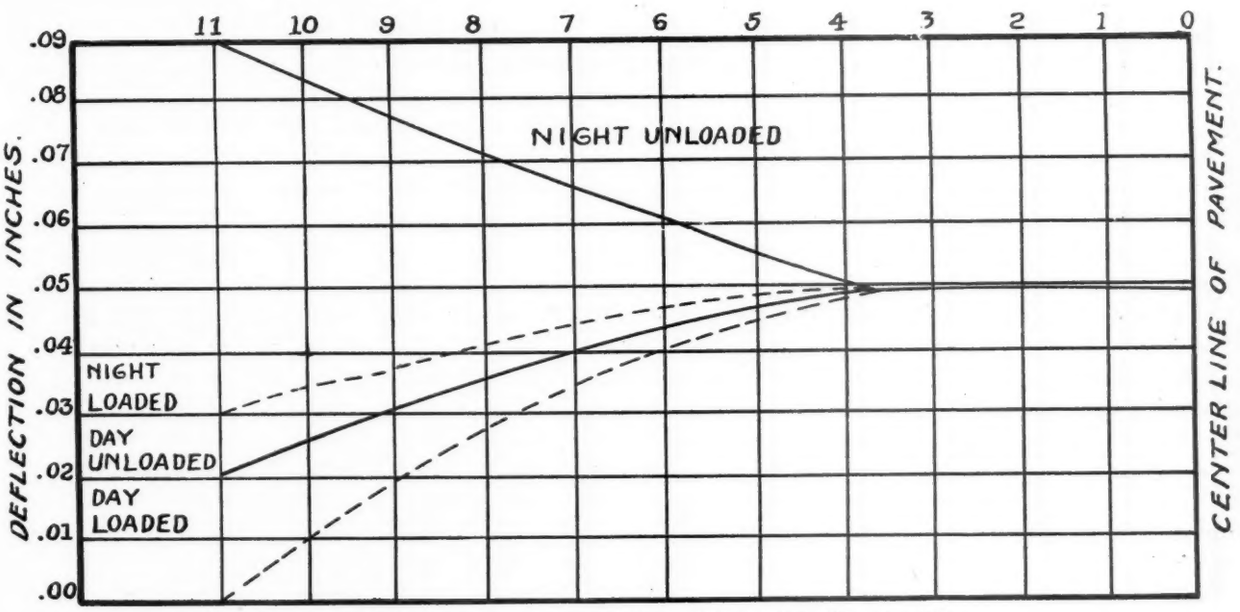
The present tendency to change the design of the concrete bases for asphalt pavements has not been the result of any necessity resulting from the failure of old bases but rather seems to be the result of an attempt to apply some of the principles derived from recent research findings relative to one course concrete pavements. It is therefore the purpose of this paper to point out the essential differences between the use of Portland cement concrete as a wearing surface and its use of a foundation medium for an asphalt pavement and to explain why the recent researches in the use of concrete for a wearing surface are only of very limited value to the designer of the concrete base for an asphalt pavement.

Presented Before the Sixth Annual Paving Conference, November 29, 1927.

After making a general inspection of approximately 5,500 miles and a detailed inspection of about 2,000 miles of Portland cement concrete roads Mr. C. A. Hogentogler comes to the following conclusions. (See Report of Investigation of the Economic Value of Reinforcement in Concrete Roads, by C. A. Hogentogler, Proceedings of the Fifth Annual Meeting of the Highway Research Board.)

1. The amount of cracking and subsequent disintegrating is a function of time; thus, the rate of cracking is a measure of the life of the pavement.

2. Longitudinal cracks in some instances were not influenced by traffic.



CURLING OF NUMBER 44 - 7 IN. PLAIN. NO DIVIDING PLANE.
CLOSED TRANSVERSE CRACK. 6,000 LB. LOAD.

Fig. 1.

3. Combined length of longitudinal and transverse cracks in slabs not more than 10 feet wide when caused by traffic alone constituted a small percentage of total cracks and joint length in the road.

The foregoing conclusions were arrived at after very careful observations and study and, in effect, mean that the cracking of concrete roads is primarily and almost entirely due to some inherent property of the concrete and not due to the traffic which it may be subjected to. In other words, practically all the cracks in concrete roads would be developed in them if no vehicle ever passed over their surfaces. This condition is so widespread that in searching for that inherent property of the concrete slab we must eliminate frost action as these cracks are common to both the northern and south-

ern parts of the United States; we must ignore varying subgrade conditions as they occur, more or less, on all kinds of grades, and likewise they are common to wet as well as dry climatic conditions. One thing that is common to all locations is that there is a varying temperature throughout the day which produces alternately a hotter upper and a cooler lower surface of the slab and the reverse condition nearly every day of the year. This condition produces an alternate curling and warping condition of the slab that has been pointed out in such researches as the reports of the Bates Experimental Road, the Pittsburgh Road Tests, and the recent researches at Purdue University.

It would seem, without a great amount of thought, that the variations of temperature throughout the day could not produce enough stress to cause cracking, but let us investigate this matter a little more closely.

Professor H. M. Westergaard, of the University of Illinois, has derived a formula for determining the tension in either the upper or lower surfaces of the concrete at any mid-point of a slab of some size, due to curling, which is as follows: (Figure 1). (See Analysis of Stresses in Concrete Pavements Due to Variations of Temperature, by H. M. Westergaard, Proceedings of Sixth Annual Meeting of the Highway Research Board, Page 205.)

Now let us see what tensile stress we may get in a concrete pavement slab made of what is known as 3,000 pound concrete at 28 days, when that pavement has reached the age of three years.

First we learn from "Design and Control of Concrete Mixtures," Portland Cement Association, Page 7, that concrete having a compressive strength of 3,000 pounds per square inch at 28 days will have a strength of approximately 5,500 pounds per square inch in three years if damp cured. Let us say that when cured in the road its strength is only 5,000 pounds per square inch.

Proceedings of the Sixth Annual Meeting of the Highway Research Board. "Analysis of Stresses in Concrete Pavements Due to Variation of Temperature," by H. M. Westergaard, Page 201. Formula to determine tensile stress due to curling.

$$s = \frac{E\,c\,t}{2(1-p)}$$

s equals the tensile stress produced.
E equals the modulus of elasticity of the concrete.
c equals the coefficient of expansion of the concrete per degree Fahrenheit.
t equals the difference in temperature between the top and the bottom of the slab in degrees Fahrenheit.
p equals Poisson's ratio for concrete.

We learn next from Bulletin No. 5, Structural Materials Research Laboratory, Lewis Institute, "Modulus of Elasticity of Concrete" that the modulus of elasticity of concrete is a function of the compressive strength. The modulus of elasticity of concrte having a compressive strength of 5,000 pounds per square inch will vary from 6,000,000 to 8,000,000 depending upon the aggregates and cements used. (See "Modulus of Elasticity of Concrete," Figs. 23 to 30 inclusive.) For the purposes of our discussion let us assume it at its lowest figure, that of 6,000,000.

Now let us refer to "Highway Research in Illinois," Proceedings of the American Society of Civil Engineers, February, 1924, page 189, where we find that the difference in temperature between the bottom and top of the slab examined on February 10 and 11, 1922, was determined at 27° F. as the Maximum, this condition occurring at about 1 P.M. February 11.

Since the coefficient of expansion of concrete is generally assumed, and usually is, about 0.0000060 per degree Fahrenheit and Poisson's rate is 0.15, we now have enough data to use the formula and determine what the tensile stress at the surface of the concrete slab may be.

Substituting in the formula we learn that this tensile stress may be as high as 572 pounds per square inch.

According to the September 1927 issue of "Concrete Highways and Public Improvements," a journal of the Portland Cement Association, a 5,500 pound concrete has a modulus of rupture of 680 pounds per square inch, on the average. In other words, the concrete may be stressed to within 84.1%, or practically 85% of its ultimate strength.

To show just what this means let us quote from Mr. Clifford Older's paper on Highway Research in Illinois, page 193, Proceedings of American Society of Civil Engineers, February 1924: "For instance, loads causing fiber stresses of about 60% of the modulus of rupture, repeated a few thousand times (rarely more than 30,000) will cause failure; for stresses in excess of 70% of the modulus of rupture, only a few repetitions (rarely more than 5,000) are required. The establishing of the fact that a tensile stress somewhat less than 50% of the modulus of rupture may be assumed as safe for a road slab, it will be of great value when analytical methods for computing fiber stresses in all parts of pavement slabs are found."

From the foregoing we see that, in the opinion of Mr. Clifford Older, it is not desirable to have a stress of more than 50% of the modulus of rupture yet the stresses that may be produced by daily temperature changes alone may at times be as great as approximately 85% of the modulus of rupture. It is also to be noted that this stress is found in the concrete regardless of the size of thickness of the slab and regardless of the presence of any plane of weakness, expansion or contraction joint. Does this not explain why it is that the amount of cracking of concrete roads is a function of time and why those cracks caused by traffic are a small percentage of the total crack and joint length in

the road? Does this not also show that the present concrete pavements may have enough beam strength for traffic loads but the elements and changing temperatures may throw the slab out of position, and that beam strength of the concrete slab, or any other type of pavement, may not be a measure of its value as a pavement.

Referring to the same sources of information let us see what the stress in a concrete base beneath an asphalt pavement may reach if we assume that we have a concrete having a strength of 1,200 pounds per square inch in 28 days.

In three years our concrete will have a compressive strength of 2,700 pounds per square inch, if damp cured, so let us assume it at 2,500 pounds per square inch as cured in the pavement base.

At the age of three years the modulus of elasticity of this concrete will average from 4,200,000 to 4,800,000 according to the same authority, so let us therefore assume that it will be 4,500,000.

In the report on "Highway research in Illinois" Mr. Older does not give data as to the difference in the temperature between the top and bottom of the concrete base beneath an asphalt pavement but on page 189 of the Proceedings of the American Society of Civil Engineers, February 1924, he shows that the warping is about 34% of what it is for the single slab of concrete. Since the warping is directly proportional to the change in temperature it will be safe to assume that the difference in temperature is 34% of what it was for the concrete slab, or about 9.2° F.

Using the values for coefficient of expansion and Poisson's ratio the same as before we find that the stress in the concrete due to this difference is only 146 pounds per square inch.

Referring to the September 1927 issue of "Concrete Highways and Public Improvements" we find that the modulus of rupture of concrete having a compressive strength of 2,500 pounds per square inch is about 430 pounds per square inch, on the average. The stress introduced into the pavement base is only 34% of its ultimate strength and is well within the safe stress of 50% of its modulus of rupture.

The foregoing discussion should disclose an excellent reason why the leaner concrete mixtures have proven so valuable as pavement bases. (Figure 2.)

In view of the fact that there is now in existence such a great area of asphalt pavements laid upon lean concrete bases which have successfully withstood the ravages of time and traffic would make it appear superfluous to spend our time in discussing this part of the subject, but there are those who believe that the asphalt wearing surface is no assistance to the structure in making it capable of carrying loads and because the structure has less strength than a concrete pavement that it is therefore inferior to the single slab type of construction unless the base is made of equally strong concrete and of the same thickness. Let us investigate this matter a little more thoroughly.

Stresses in Concrete Pavement and Concrete Foundation Produced by Curling, according to Westergaard Formula:

	Concrete Pavement	Concrete Foundation
Compressive strength of Concrete at the age of 28 days, lbs. per sq. in.....	3,000	1,200
Compressive strength of Concrete at the age of 3 yrs., lbs. per sq. in.....	5,000	2,500

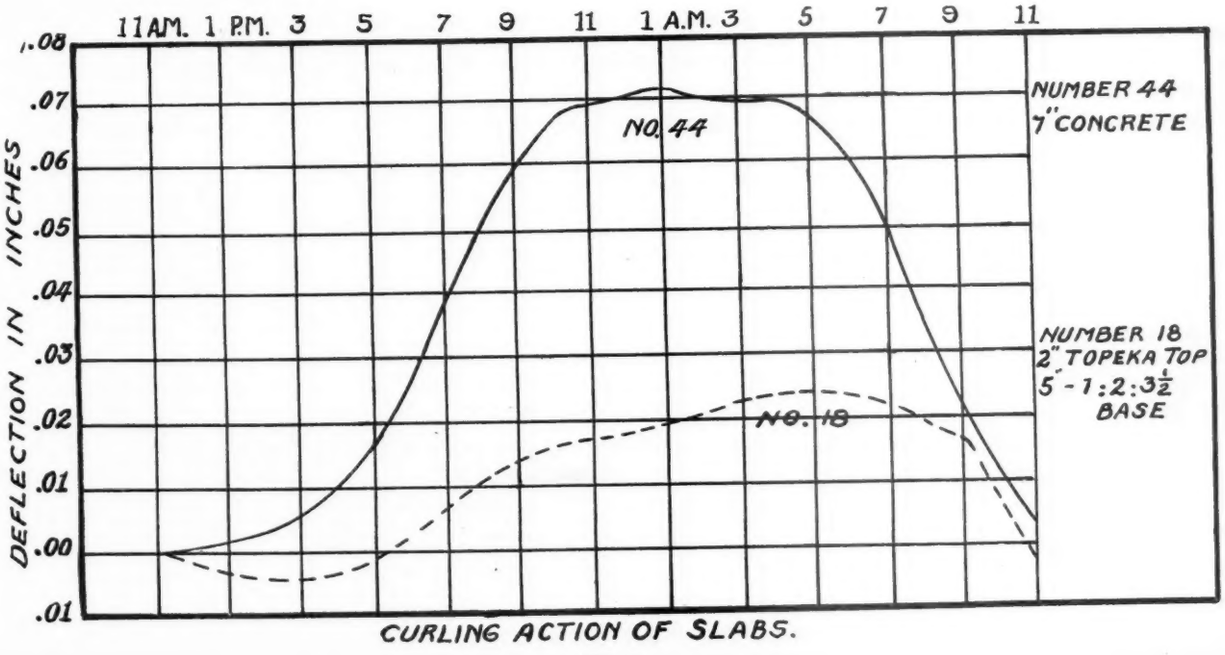


Fig. 2.

Modulus of elasticity of Concrete at the age of 3 yrs., lbs. per sq. in.....	6,000,000	4,500,000
Coffiecient of expansion of Concrete per degree Fah..	0.0000060	0.0000060
Poisson's ratio for Concrete	0.15	0.15
Difference in temperature between top and bottom of slab in degrees Fah.....	27	9.2
Tensile stress in Concrete, lbs. per sq. in.....	572	146
Modulus of rupture of Concrete, lbs. per sq. in.....	680	430
Stress, percentage of modulus of rupture.....	84.1%	34.0%

The destructive forces which act upon the pavement structure, aside from the variations in temperature, which we have already examined, may be listed as those causing vibration and those producing direct pressure such as a standing or a very slowly moving load.

The destructive effect of vibrations on the pavement structure is so ably described in the July 1925 issue of Municipal and County Engineering, by Mr. S. B. Moore and Mr. F. A. Tondorf, in their article on "The Destructive Forces in Pavements," that I would like to take the following quotations from this article:

"Army engineers first developed modern pavements as we find them in the District of Columbia. Records exist of some of these pavements, with a 42½-in. and 5-in. base of 1:3:6 concrete, asphalt topped, that have stood up well nigh half a century. On the other hand, many concrete slabs, unprotected by an asphalt top, have been destroyed both from bending stresses set up by excessively heavy loads and from vibration stresses. Some underlying cause is necessarily responsible here." . . .

"We shall not attempt to show that these methods are in accordance with the principles of mechanics. To ascertain the causes of vibration failures, the co-operation of the Seismological Service of Georgetown University was enlisted.

"An unsurfaced concrete road borders within 150 feet of the cave that houses the seismograph of this department, thus making possible the registration of any vibrations set up in these elements.

"Our first step was to establish the character of the vibrations in the unsurfaced concrete road, to serve as a control. Heavy vehicles were driven along the road at varying speeds, in an east-west direction. Strangely enough, the graph from the instrument for recording vibrations showed a maximum movement in a north-south direction, with a hardly perceptible movement at right angles to this line.

"The logical interpretation here seems to be that the vehicle in transit is continuously deviating from a right line and, consequent to this zigzag movement, is inaugurating in the concrete base pronounced twisting strains. These strains must naturally be proportioned to the grip of the tire on the surface and, therefore, the greater the grip, the greater the stress, that we will call torsion. Again, the grip being a function of the width of the tire, the wider the tire the greater the torsion." . . .

"Following these tests upon the unsurfaced road, a portion was topped off with 1½-ins. of asphalt. On running the loaded truck with the wide tires over the test section, the character was similar until the cushioned surface was reached and then the breaking of the grip of the tires on the base at once reduced the intensity of the vibrations by three quarters.

"On leaving the cushioned surface, the intensity of the vibrations instantly increased.

"To confirm this interpretation, the length of the asphalt top was extended. This gave a proportional extension of the decreased intensity, and is evidence that the breaking of the grip of the tires from the base results in reducing the vibration about 75 per cent. This ratio was indicated in each instance.

"As the eliminating factor of vibratory motion is a sole function of the mass of the structure, it is an easy compilation to ascertain the mass of an unsurfaced slab which will resist this to and fro movement.

"That many 5-inch bases with wearing surfaces of asphalt have given long service without deterioration, is well known. Reading the intensities of the vibrations in a surfaced slab and comparing them with those in one not surfaced, the problem stands solved. In our case, the proportion reads:

$$.25 : 5'' :: 1.10 : X = 20''.$$

"Clearly then, an unsurfaced slab, to be capable of resisting vibration strains, must have four times the mass of a slab protected by a deadened surface to resist like oscillations.

"To eliminate any possible ambiguity regarding the excessive grip of wide tires, the same truck as indicated above of 24,400 lbs. was run over the test section empty. Its speed was increased to 20 miles per hour, an increase of eight miles per hour over the speed at which the loaded truck was run.

"The graph showed the intensity of vibration in either case to be the same. This demonstrates conclusively that the destructive vibrations are to be rated not in terms of weight but in terms of grip."

The fact that vibrations set up by the passage of vehicles was reduced to 25% of what they were in the unsurfaced concrete shows without question that the asphaltic surface assists very materially in preserving the concrete base and it is therefore not necessary to have concretes of such great strength if they are to be used as a base beneath an asphalt wearing surface. This statement is made regardless of the conclusions of Mr. A. T. Goldbeck after making impact tests upon pavement slabs at Arlington, Virginia. (See transac-

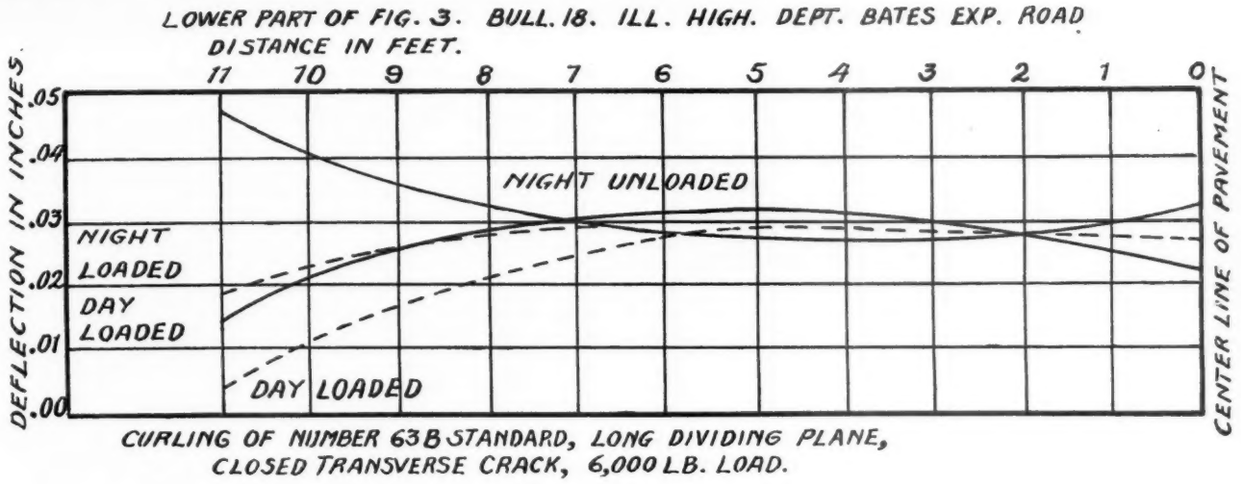


Fig. 3.

tions of American Society of Civil Engineers, 1925, page 291, "Researches on Structural Design of Highways".) Mr. Goldbeck's conclusions were, "There is very little evidence of 'cushioning' due to bituminous tops at temperatures of 32° C. (90°F.) or less." Also, "bituminous tops do not seem to add to the slab strength of a concrete base with the possible exception of the 4 and 6-in. bases on a dry sub-grade."

These tests at Arlington, Virginia, are not proper evidence upon which to base such sweeping conclusions for two reasons. In the first place the equipment used was designed to deliver a vertical equivalent impact as compared to the vertical impact of the passage of a loaded motor truck, while we see from the foregoing article by Messrs. Moore and Tondorf that the vibrations set up in the structure are horizontal, at right angles with the centerline of the pavement, as well as vertical. The vertical impact represents only one element of the force acting upon the pavement. Secondly, the tests were not made upon slabs under the conditions found in the actual pavement structure for the reason that the pavement slab is usually warped or curled and parts of the structure are off the subgrade. In the case of the unsurfaced slab this condition is much more marked than for the surfaced slab. On page 185, Proceedings of the American Society of Civil Engineers, Feb. 1924, Mr. Clifford Older says, "Corner warping of as much as ¼ in. often occurs in slabs 18 ft. wide. These observations, together with others relating to subgrade support, including pressure cell readings, confirmed the belief that rigid pavement slab corners frequently may be required to sustain passing loads while acting as unsupported cantilevers." This condition could not prevail in the case of the tested slabs on account of their size. Therefore, the results were tests upon the ability of small pieces of concrete to withstand vertical shocks when uniformly resting upon various subgrades. In other words, it was a true test of slab strength with a uniform subgrade and not a test of various pavement designs as actually used.

To illustrate the difference let us assume that we have a single slab concrete pavement 22 feet wide as given in the upper part of Figure 3, page 11, Bulletin No. 18, of the Illinois Highway Department, "Bates Experimental Road" (Figure 3). We notice in this diagram that the full width road curls upwards to .09″ at night when unloaded. When loaded at night with a 6,000 pound load it goes back to a position indicated as .03″ or a distance of .06″. In the daytime when unloaded the edge of the slab is at a position indicated as .02″ and when loaded it is at a position indicated as 0.00″ a difference of only .02″. The total difference in the daily and nightly deflection is .04″. This is doubtless caused by the fact that the day load is partially supported by the subgrade and therefore the deflection is only one-third of what it is at night.

Now let us refer to Figure 5 in the publication and we see that the total warping of the asphalt surfaced concrete is only about .024″. Under its most trying condition a heavy load will deflect this slab so that it is partially supported by the subgrade. In other words, the subgrade will always function beneath an asphalt surfaced pavement, therefore it is not necessary to have such great beam strength in our concrete bases since they are always assisted by the subgrade.

From this discussion you may readily see why the Arlington tests did not disclose the true conditions of the pavement structures since all concrete slabs and bases were equally supported in each case and the test was simply a test of relative beam strengths and not relative pavement designs.

A careful study of the foregoing information will conclusively show that the use of rich concrete mixtures for bases beneath asphalt wearing surfaces is not necessary and is a great economic waste.

Center Joints

The discussion of the use of expansion and center joints was left until this time on account of the

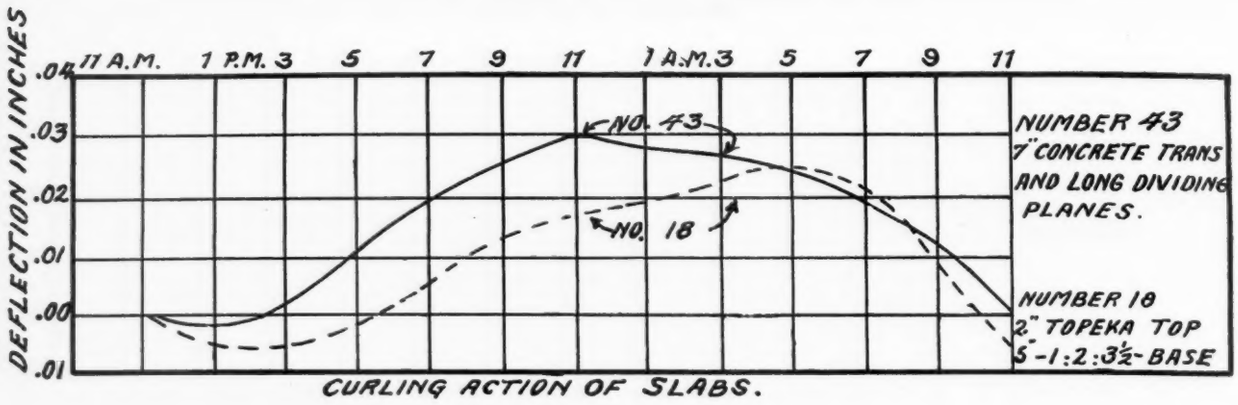


Fig. 4.

fact that it is necessary to understand the foregoing before we are prepared for this discussion.

The use of center joints in pavement bases is doubtless the result of their usage in the design of Portland cement concrete roads and pavements. The introduction of the center joint in the concrete road was resorted to in order to reduce the total to which the edge of the concrete slab might be raised on account of curling. It is interesting to note in this connection that such center joints in no way reduce the stress in the concrete due to curling for we remember that the formula for determining the stress due to curling does not include consideration of the extent of the slab. In other words, the unit deformation in the slab is just the same.

Since this center joint is used for the purpose of reducing the life of the edge of the pavement at the time of curling why should this joint be introduced into the concrete base under an asphalt wearing surface when our only information shows that the curling of the base under this pavement is even less without this joint than the concrete pavement is with the joint in it. (Figure 4.) Further, if a center joint is used it is absolutely certain to produce an unsightly longitudinal crack in the wearing surface while if such a joint is not used these cracks seldom appear unless the pavement is laid over a poor subgrade.

Expansion Joints

Of the recent variations in the requirements of specifications for concrete bases it is likely that the use of an expansion joint is the most logical, in some instances, for these are cases where concrete bases require expansion joints to prevent crushing and heaving due to their swell in volume as a result of increases in moisture content and rises in temperature. It is interesting to note in this connection, however, that the leaner mixtures are less apt to blow up than those of higher cement content. (See "A Study of Crushing and Heaving of Concrete Pavement Bases" by Roy M. Green, Municipal and County Engineering, May 1924.) The use of such joints is not always necessary, however, but it is a fact that there are some aggregates that produce concrete that is very prone to blow up when used as a pavement base. If an aggregate has been successfully used in the past without this defect developing it is certainly not desirable to use expansion joints at all, and in any event it is not desirable to use a bituminous filled, or sand filled joint of any of the usual types.

If a bituminous expansion joint is used, during hot weather the joint filler will have a tendency to squeeze out and raise the surface of the pavement sufficiently to make a very unsightly and undesirable condition.

The sand filled joint will not function as an expansion joint at all after a very short period of time.

The practice of leaving a ¾" gap in the base and simply covering it with the wearing surface is also only partially effective. After a short period of time a crack will, of course, appear in the wearing surface allowing dirt to accumulate in the joint. At a later period this dirt will become concentrated at the edges of the pavement and subsequent expansion will always blow up the base at these points.

If it becomes necessary to use expansion joints on account of any peculiarities of aggregate it is well to leave a short gap of say ¾" about every 150 feet and then cover this with a metal plate so as to prevent any dirt accumulating in the joint at any future time. This will, of course, cause a crack in the wearing surface at the joint but this can later be filled with a bituminous cement. Such joints will function properly for an indefinite period of time. We have a number of such joints that have been in use for four years that were placed in

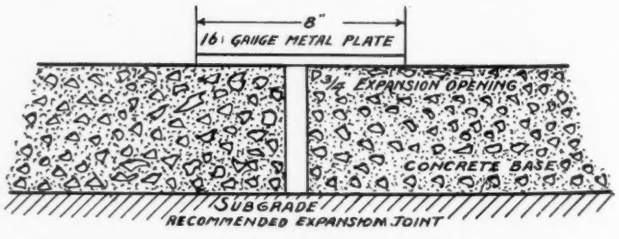


Fig. 5.

concrete bases produced from gravel that is very apt to blow up during the first two years the pavement is in use. Up to this time these joints have functioned perfectly. (Figure 5.)

As has been said before, however, the use of expansion joints in the concrete base beneath an asphalt wearing surface is undesirable unless an aggregate is being used that produces a concrete that is prone to blow up.

Reinforcing in Concrete Bases

On page 15 of the "Report of Investigation of the Economic Value of Reinforcing in Concrete Roads" by Mr. C. A. Hogentogler, we find the following statement under the heading of "Reinforcement": "Steel reinforcement in concrete pavements seemed to serve two purposes. First it delayed the appearance of visible cracks, and second it held the fractured parts of surfaces together after cracking had occurred. The steel also assists in preventing raveling at such cracks as are formed. Let us now investigate the causes of cracking in the case of the concrete pavement and in the case of the concrete foundation course.

Concrete pavements develop transverse cracks primarily on account of the shrinkage of the concrete upon curing and as a result of daily variations in temperature, also, as a result of seasonal variations in temperature and changes in moisture content. The same causes of cracking will prevail in the case of the concrete foundation, but to a much less extent.

Cracks due to the shrinkage of the concrete during the curing period will be just as numerous in the concrete foundation as in the unsurfaced concrete pavement and these cracks will usually be from 30 to 60 feet apart, usually about 35 feet.

Cracks due to daily variations in temperature will not be nearly as numerous and should be practically negligible on account of the small variation in temperature between the bottom and top parts of the foundation slab and the resulting smaller stress in the concrete as has already been demonstrated.

Cracks due to seasonal changes in temperature and changes in moisture content should be much less as the moisture content in the base will be much more nearly uniform on account of the insulating effect of the wearing surface. The seasonal variations in temperature will also not be so sudden.

In the case of foundations it is not necessary to have steel to reduce the raveling of the concrete at the edges of cracks.

In other words, the necessity for reinforcing in bases is not nearly so great as in the case of the one course pavement.

Now let us assume that we have a concrete base that is reinforced and we will see what develops in connection with the prevalence of transverse cracks. Mr. Hogentogler says, page 16, "The impracticability of having steel in bond function over considerable lengths (more than 100 feet) was evidenced in both bar and mesh reinforcement by cracks appearing at definite intervals (60 to 100 feet) with clear openings ($\frac{1}{16}$ to $\frac{1}{4}$ in.) and raveling similar to those in plain concrete. This indicated that if the reinforcement had not broken, at least one of the chief benefits had been lost." In other words, if reinforcing is to be effective in preventing cracks we must either leave a small area with no steel in it or place an expansion or contraction joint at intervals of 60 feet or less to make sure it will be effective and thus put the cracks in the pavement that we are attempting to eliminate. It would appear that we are just as amply protected against transverse cracking without the steel as with it.

In the case of longitudinal cracks it is apparent that such cracks are due to daily temperature changes causing warping and curling and also due to poor subgrade conditions.

We have already seen that the insulating effect of the wearing surface is ample protection against cracks caused by daily variations in temperature.

Poor subgrade conditions have caused longitudinal cracks in concrete bases, however, and when it is known that such subgrade conditions prevail in any area it is well to use the reinforced base. Our present knowledge of subgrades is so meager, however, that it is very hard to forecast when such conditions are to be met and it is questionable whether these conditions can be foretold at all. If reinforcing is used where it is not necessary it is naturally an economic waste and in most cases it is probably better to lay the base without the steel and then care for these few places that may give trouble after it is apparent that such trouble has been encountered.

Summary

1. In a plain concrete pavement "the amount of cracking and subsequent disintegration is a function of time." "Combined length of longitudinal and transverse cracks when caused by traffic alone constituted a small percentage of total crack and joint length in the road."

2. In a concrete pavement the stress due to daily variations in temperature may be as great as 85% of the modulus of rupture of the concrete.

3. In a lean mixture of concrete used as a foundation under an asphalt wearing surface the stress due to daily variations in temperature may be as high as approximately 35% of the modulus of rupture of the concrete.

4. Repeated stresses of more than 50 per cent of the modulus of rupture are excessive for concrete.

5. Asphalt wearing surfaces very materially assist in reducing the vibration stresses in the supporting concrete foundation.

6. Concrete pavement slabs are forced to act as unsupported cantilevers during most of the time while a concrete base is always assisted by the subgrade and it is therefore never necessary to have such high strength concrete in such foundations.

7. Center joints are unnecessary to reduce the curling effect in a concrete foundation because the curling is almost negligible. Such joints are undesirable because they always produce an unnecessary crack in the wearing surface.

8. Expansion joints in a concrete foundation are not desirable unless an aggregate is used in the concrete which will cause blowups. If such expansion joints are used they should be specially designed so that they may function permanently.

9. Steel reinforcing is not so necessary in a concrete foundation as in a concrete pavement wearing surface and is usually undesirable. Reinforcing is not effective in reducing transverse cracking but may be of assistance in preventing longitudinal cracks in some instances.

Non-Metallic Work in Illinois During 1927

The program of the Illinois Geological Survey in the non-metallic mineral fields, not including fuels, during 1927 has been reasonably full. During the year a short bulletin dealing with the causes of disintegration and methods of testing limestone for sewage filter beds has been published and a bulletin covering an economic and scientific study of the St. Peter sandstone is now in press. This sandstone is the source of the high silica sand of northern Illinois.

The summer's field work consisted of a study of the economic mineral resources of the southern tip of Illinois, particularly the southern Illinois Ozarks. This region, whose resources have been but little known, contains a variety of high grade clays, fuller's earth, silica, ganister, high grade limestone, sand, gravel, and ochre. During the summer of 1926 Dr. E. S. Bastin of the University of Chicago made a detailed study of the fluorspar resources of southeastern Illinois and the report covering this investigation is in preparation.

The Survey's program in non-metallics as outlined for 1928 includes the testing of samples taken during the field season of 1927 and the publication of data bearing on the results of these tests; and field studies for further evaluation of the non-metallic mineral resources of southern Illinois, particularly the fire clays underlying the strip coals of that area.

The 1926 production figures for the mineral industries of Illinois have recently become available. The total value of the non-fuel product in 1926 was $71,220,241 as compared with $67,450,118 in 1925, or an increase of 5.6%[1]. The changes in mineral production are shown in the following table.

Maintenance of Interior Marble

The reserach conducted by the Bureau of Standards in co-operation with the National Association of Marble Dealers was completed in March, 1927. The results of this work have been published in Bureau of Standards Technologic Paper No. 350, entitled "A Study of Problems Relating to the Maintenance of Interior Marble." An abstract of this paper has also been published by the National Association of Marble Dealers in a booklet entitled, "The Maintenance of Interior Marble." These publications contain the results of investigations to determine the undesirable effects which may occur due to the use of certain types of cleaning preparations, recommendations as to cleaning preparations and methods for cleaning marble, injurious effects of various salt solutions which may penetrate marblework under various conditions of use, methods of removing various kinds of accidental stains from marble, and recommendations for means of installation of marble to prevent certain troubles from discoloration or disintegration.

Quite an Improvement

T. Tarborg, of The Logansport Stone and Lime Company, Huntington, Indiana, comments on Pit and Quarry as follows: "The new Pit and Quarry is quite an improvement over the smaller formerly issued."

CHANGES IN MINERAL PRODUCTION 1925-1926[1]

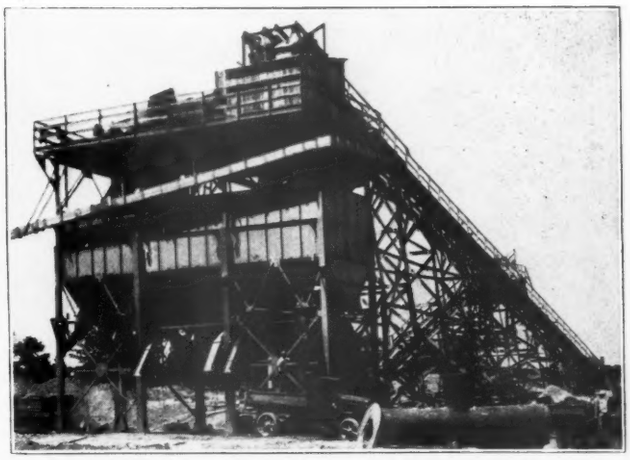
Product	Per cent change over 1925 Amount	Per cent change over 1925 Value	Production 1926 Amount	Value
Cement (Portland)	[2]	−4.3	6,747,241 bbls.	$10,998,002
Clay-products		+7.3	.....	39,463,202
—raw	−5.9	+6.8	205,926 tons	410,476
Fluorspar	−13	−1.1	[3]	[3]
Lime	+7.5	+9.2	103,180 tons	1,013,740
Fuller's earth	+30.0	+23.0	[3]	[3]
Sand and gravel	+18.9	+7.0	17,777,169 tons	8,714,350
Ground sand (silica)	−3.6	[2]	[3]	[3]
Stone	+6.6	+9.8	9,145,180 tons	8,479,277
Tripoli	+1.7	+3.4	[3]	[3]

[1]Figures on peat, marl, mineral paints, mineral water and sulphuric acid not available.
[2]Very slight decrease.
[3]Three producers or less. Total production of fluorspar, fuller's earth, ground sand, and Tripoli 182,763 tons. Value $2,141,194.

SPEED IN HANDLING PRODUCT FROM PLANT IMPORTANT TO COMMONWEALTH COMPANY

SERVICE appears to have been the paramount factor in the design of the new plant recently completed by the Commonwealth Sand and Gravel Company just outside of Richmond, Virginia. The ability of this company to handle with speed the distribution of its product is largely due to the installation of a specialized type of bin unit designed and installed by experienced engineers to make the maximum service possible.

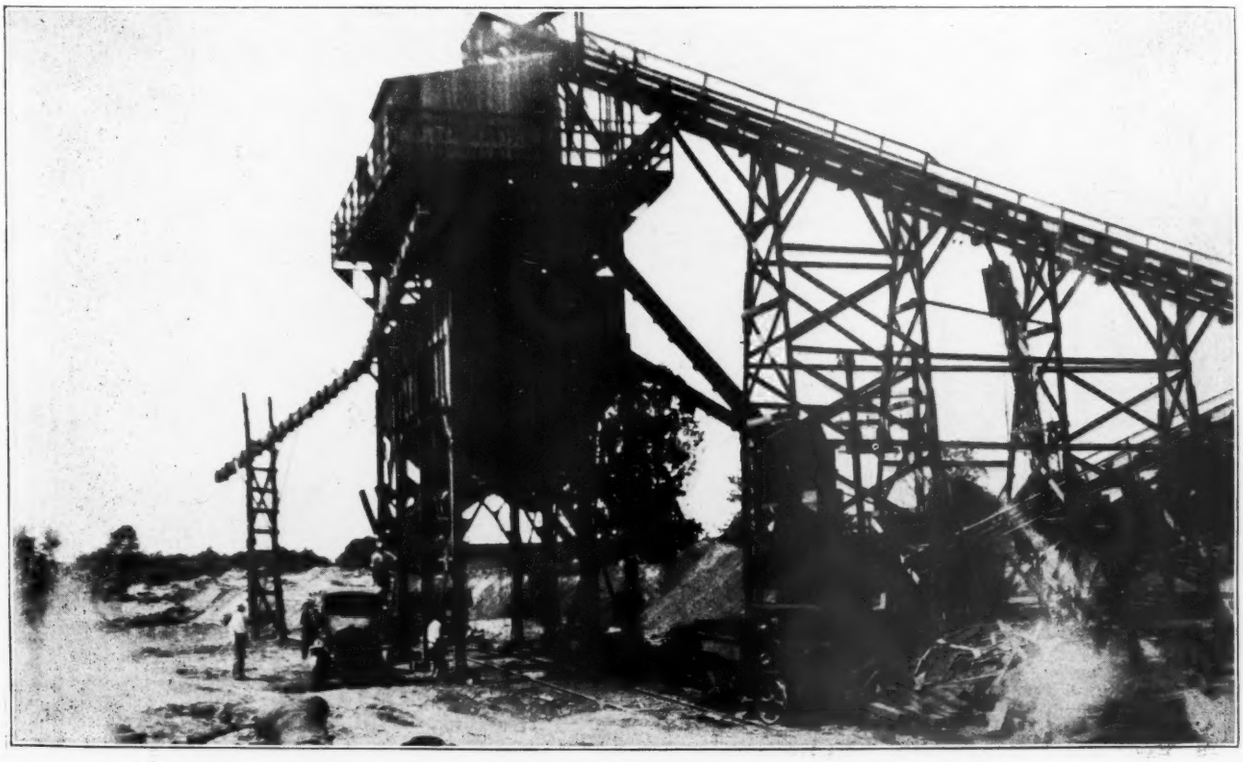
These bins were built by the Butler Bin Company and as is shown in the accompanying illustration are of steel construction. The bins are formed of standard steel plate reinforced strongly at all corners and vital points and the steel posts resting on concrete footings. The steel frame is designed to meet the maximum weight of the bin load with sufficient factor of safety to allow for any condition of service. The framework is braced with steel members to insure maximum stability against any shock. The bins are elevated on longer and heavier columns than usual in order to allow a clearance of 16 feet between top of rail and bottom of radial gate. The side gates and spouts are of special design. There are three bins of 200 cubic yards capacity each. Two of these are divided into two compartments thus providing for three sizes of gravel and two of sand. The bins discharge on both sides and through the bottom so that trucks can be loaded from one side and railroad cars from the other side and from the bottom



Close-up View of Bins

all simultaneously. The illustrations show cars being loaded from the bottom and trucks from both sides. This is only for the present. Another railroad track is to be run along one side and a concrete road for trucks is to be built along the other side. Radial gates are opened to load cars and the spouts feed trucks on one side and railroad cars on the other. The gates on the sides are not placed directly opposite each other but a little above each other.

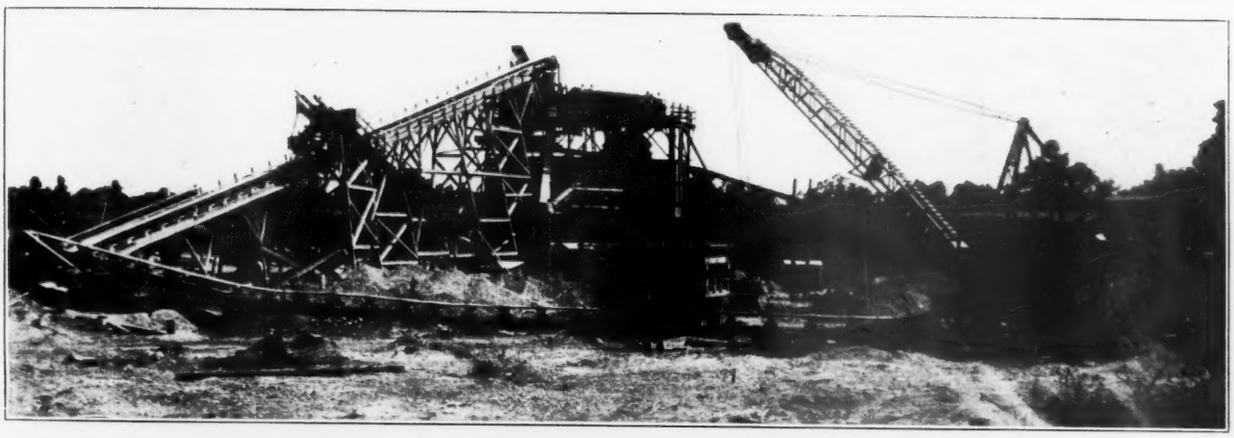
The deposit covers 100 acres with excellent gravel varying from 25 to 40 feet in depth. The property is on the right-of-way of the Chesapeake



Screening and Loading Plant

Steam Dragline Excavating

Looking Under the Bins



Top Shows Portion of Deposit. Center Shows General View of Plant. Bottom Shows View Under Bins Looking Toward Deposit.

and Ohio Railroad and a short spur track connects the plant with the main line. The plant capacity is 1000 tons per day. Material is excavated by a Bucyrus steam dragline equipped with a two yard bucket. The dragline loads the material into a field hopper. The material is fed from the field hopper to a belt conveyor which delivers the material to a Telsmith scalping screen. The oversize from this screen is chuted to a Telsmith crusher and after crushing elevated back to the same screen. The material passing the scalping screen goes to another Telsmith cylindrical screen equipped with three sizes of perforations and a jacket. The graded sizes drop directly to their respective bins. The plant is electrically operated and one man only is required for the screening operation. Water for washing is secured from a reservoir on the property.

L. G. Thom is vice president and general manager of the Commonwealth Sand and Gravel Company and is in charge of the plant. G. E. Jordan is his assistant.

Two New Explosives Developed During Past Year

Gelatin dynamites have been favorites for years for pit and quarry mining because of their good fume and water resistant properties and the ease with which they can be loaded in bore holes. They contain sufficient oxygen to completely transform all carbonaceous ingredients to carbon dioxide, their gelatinous character makes them impervious to water, and their high density and plasticity permits of ideal concentration. Gelatins, however, cost more per cartridge than other explosives and there are times when the consumer pays dearly for fume and water protection that is not necessary. Straight Nitroglycerin explosives, which average 20 per cent more 1¼x8 inch cartridges to the 50 pound case than gelatin, sell for the same price as the similar strength gelatin. It follows that the cost per cartridge of the straight Nitroglycerin type explosive is relatively lower. The straight Nitroglycerin type of explosive, however, developed fumes that endangered the health of the miners and these explosives could not be used in confined working places. To permit of this their oxygen balances had to be altered to prevent the development of noxious and poisonous gases.

This has been a problem which has required considerable study and experimentation but the past two years has seen its solution with the result that a new series of good fume Straight Nitroglycerin explosives ranging in strength from 20 to 40 per cent has been produced.

It is possible with grades of this series to replace gelatins of similar strength on a cartridge for cartridge basis; the saving in terms of the gelatin will be 20 per cent. As they have good fumes, they may be used in confined working places; as they have fairly good water resistance, although not as good as gelatins, they may be used in many fairly dry mines in blasting such materials as limestone, gypsum, salt, bauxite, and clay. They may also be used for stoping in metal mines. They are of a granular character but as they are also cohesive the cartridges are slightly soft which permits of their being concentrated in bore holes without the need of slitting. They are cartridged by mechanical means which attests to their safety from impact, for if they were too sensitive the manufacturer could not afford to endanger life and property in his works by mechanical loading. However, their sensitiveness is of a positive character and is greater than that of the gelatins or the ammonium nitrate Nitroglycerin mixtures of explosives with which they will compete. As a result complaints of burning of charges in the bore holes because of the lack of sufficient sensitiveness in the explosive or incomplete detonation of charges for the same reason, are to a great extent eliminated. The composition of these explosives is such that they should not harden or set with age. Lastly, they are made so immune to freezing that they can be used without thawing in the coldest localities.

The foregoing series provides more economical grades than the gelatine for work which can be somewhat wet and where concentrated strength developed at fairly high velocity is required. Mineralized formations of copper, lead and zinc, bauxite and clays generally require a fast acting explosive. There are, on the other hand, certain formations of salt, of limestone, and of gypsum that are most effectively disrupted by the employment of explosives that produce more of a heaving action and since these operations are in most cases dry, there has been provided an opportunity for the replacement of the gelatins, which have been used heretofore, by a much less dense type but at the same time of sufficient strength that they can be used on a cartridge for cartridge basis with the gelatins. In other words the comparatively dry conditions of the mining and the breaking qualities of limestone, salt and gypsum permit of the use of an entirely different type of explosive from either this new series of good fume Straight Nitroglycerin explosives or the gelatins and a second series of new explosives has resulted.

The main explosive ingredient in this second series of explosives is Ammonium Nitrate. They are similar to the Ammonium Nitrate base permissible explosives in general composition but have not been passed as permissible by the Bureau of Mines.

Relative to their properties, their fumes permit of their use in confined working places, their water resistance is sufficient for damp bore holes, their freezing resistance satisfactory for use without

(Continued on page 61)

COST ACCOUNTING AND ITS APPLICATION TO THE MINERAL AGGREGATE INDUSTRY

By Colonel Carl Penner,
Reilly, Penner and Benton*

TRADE associations in general have found in the development of accounting and cost data for their industries one of the most important ways in which they can benefit their industries. Practically all of them have found it necessary to interest themselves in the subject to a greater or less degree, ranging from the simple type of report which your association requests from its members to the most detailed and elaborate cost and general accounting systems. Some trade associations have used so-called "uniform cost systems" as a substitute for price fixing agreements and some injury to the development of honest cost accounting for trade associations has resulted and a few associations or their members have landed in the federal or state courts charged with conspiracy in restraint of trade. Nothing is farther from our minds than to advocate cost accounting as a basis for price fixing or for raising prices although we do say that frequently the determination of correct costs is going to result in raising selling prices. Not by an understanding that all members of an association will adopt as their costs the figures which the association may arrive at as being proper or average costs, but by a determination by each member of his own costs, under a classification which will be fairly uniform for all members so far as the differing circumstances of each permit. We are not aiming to eliminate competition between members, which would not only be illegal but would have no lasting good effect, human nature being what it is. What we do wish to accomplish is the elimination of blind competition and the only way to do it is through a knowledge of correct costs of production and distribution by all of those who are producing and selling in a common market.

Possibly all of you have a very clear conception of what I call blind competition but I am going to talk about it a little more because unless you appreciate its harmful results, the rest of my talk might as well be omitted.

Budgeting for a New Business

Let us assume the case of a company organized for the production and sale of sand and gravel by people who understand the business of production, delivery and selling well enough. The thing they know best perhaps, is the prices they will have to quote to get a volume of business proportionate to their capacity, and as prudent business men they will sit down with a pencil and paper and do some figuring before committing themselves to the project. They have a pretty good idea of the equipment they will need, of the number of men required for stripping their pits and operating the excavating and loading equipment, and what they will have to pay such labor; they can make good estimates of the supplies they will require and the expenses they will incur in supplying power, water or whatever else may be needed, and in keeping their equipment in repair. They will make allowance for estimated overhead expense to cover superintendence, administration, sales and other items of that nature. Two items that they would probably include but might overlook are depreciation of equipment and structures and depletion of their mineral deposits. They can estimate how much material they can produce and deliver, providing they have the orders, and that the orders are so distributed as to permit of fairly continuous operation. They know that during a part of the year weather conditions are such that production and delivery will be stopped or interfered with although expenses of many kinds will go on, and if they are wise they will make allowance for such stoppages. They will take all these factors into account and arrive at an estimate of total costs and expenses for a year and they will divide that sum by the number of tons they expect to produce. If the result is low enough to leave a margin between cost and selling prices which will give a return on capital sufficiently larger than ordinary interest to warrant the risk that always attends a business venture, they will feel justified in going ahead with the project. The selling prices of course will usually be governed by the conditions prevailing in a competitive field and they must expect to meet them.

The process I have just described whether it is done on specially designed forms or on the backs of old envelopes, is budgeting for a new business. Budgeting for an old established business is different only because the budgeters have the records of past experience to guide them. The value of these records of past experience depends upon the manner in which they were compiled, and to compile them so that they will be valuable as a guide to the future conduct of business is what we mean by applying cost accounting to the mineral aggregate industry. The accounting is the proof of the pudding and is the real test of the foresight and judgment exercised in preparing the forecast. The accounting must do more than show what the profit

*Presented before the Wisconsin Mineral Aggregate Association, December 7, 1927.

or loss is at the end of the year. Providing the producer intends to stay in business his accounting should tell him where actual results of the year's operations differed from the expected. If he came out with a loss or with less profit than he had calculated upon in advance his accounts should point out the factors that must be changed in order to do better next year. The solution might lie in a larger volume of business even at lower prices, but it might be the fact that a larger volume at the same prices would only increase the loss. He is going it blind unless he has the facts that adequate cost accounting can give him.

Cost Accounting Simple

When the subject of a cost system is considered by the average business man he has a vision of an endless array of time reports, material requisitions, production orders and other accounting forms, with numerous clerks and cost accountants to keep it all in order. Those things may be necessary in the cost accounting for complex manufacturing processes, but fortunately for your industry very little more is required than most producers find necessary anyway. Production which reaches any considerable volume requires the services of a competent bookkeeper anyway and in order to get the accounting facts most valuable to the management it would simply be necessary to do about the same amount of work on a somewhat different plan.

In fact, I think that the only really important thing I have to say to you today, is that the application of cost accounting to the mineral aggregate industry, in the case of most producers, means simply a little further developing of the accounting systems already in use plus the application of production records to the accounting results, tabulated in such form that comparisons can be made of actual results with expected, or of the current period with prior periods.

Two things which I have just touched upon are fundamental; the accounting system, which is a complete record of the financial transactions, and the production record, which should be a complete statement of the number of units of material produced, arranged to show sources of production, classes of material, and manner of delivery.

Classification of Accounts

The important thing in the accounting system is the classification of the general ledger accounts and particularly those that record the operating expenses. The grouping of these accounts is all important and I will try to explain why classifications suitable for some purposes are not useful for cost accounting. For instance, if we were keeping accounts only for the purpose of showing a final figure of profit or loss, or for the requirements of tax returns, we might have one account each for wages, repairs, depreciation and so on down the list appearing on the tax return blank, but the resulting figures would not help us much in analyzing costs.

For cost purposes, taking the sand and gravel industry for illustration, we have to consider first the two great main divisions of the industry—production and distribution. Each of these is again subdivided into operating departments, the two main subdivisions in the case of production being stripping and plant operation, the latter covering all the processes necessary after the overburden has been removed, to place the screened material at the loading point ready for delivery. The separation of stripping from the plant operations having to do with the mining, screening, washing and loading is made because it is a natural departmental division. Stripping is an element of cost that precedes actual production; the amount of stripping done during a particular accounting period does not necessarily correspond with the amount of production during that period; the stripping crew is usually independent of the plant operating crew; separate equipment is used, and most important of all, a knowledge of stripping costs, as a separate item, is valuable information to the producer because it is an important element of cost. Also, at the end of any accounting period the cost of stripping done in advance is an asset, chargeable to expense in a future period, being treated for accounting purposes just as inventories are handled.

Within a department of the operations such as stripping, which is rather a simple affair, there would be no further accounting subdivision by operations, but there would be a number of accounts to record the various classes of direct expenditure, such as superintendence, labor and the various kinds of expenses involved in operating teams and equipment, including the maintenance and depreciation of the physical property used in the department.

Similarly, plant operation can be handled as a whole, with sub-accounts only for the classes of expenditure incurred in operating the department, although on account of the greater complexity of the operations and of the equipment used, the accounts will be more numerous. For producers who operate a number of plants there would be an advantage in accounting for each as a separate department so as to make comparative costs available.

Cost of Delivery

The other great division of the industry, distribution, does not offer much of a problem in cost accounting, as the bulk of the material is shipped by rail and the customer pays the freight. For those producers who deliver by truck from the pit or from branch yards, the cost of delivery is a very

important factor, being frequently higher than all other costs up to that point. To collect these costs accurately requires first that all of the delivery equipment be carried in a property account separate from the other physical assets so that separate depreciation charges can conveniently be made. The expense accounts for operation and maintenance should be quite detailed and considerable benefits result from accounting separately for each truck, although this involves considerable additional clerical labor.

Just as in the production division we are aiming at ascertaining a cost per ton at the point at which delivery begins, so in the distribution division we are aiming at a cost per ton at the point where the customer receives it. The latter, however, fluctuates very materially by reason of the distance from the producing point to the delivery point, so, whereas the production unit is the ton, the truck delivery unit is the ton-mile.

Statistical Records Considered

This brings us to a consideration of the statistical records that are necessary to make our accounting records mean anything from a cost standpoint. In the plant operation end it is necessary to build up from daily records of production the total tonnage for the accounting period, separately by plants, if more than one is operated. The tonnage of each plant should be kept by classes of material. This statistical record is not a difficult matter at all as it means simply a tabulation of shipments during the period, adjusted by inventories, if any, at beginning and end.

Truck delivery statistics are somewhat more of a problem for the reason that distances of delivery points enter into them, which necessitates mileage reports and their tabulation.

Having accumulated our production and distribution expenses separately for the period from our accounting records, taking care to include in them those that are often overlooked because they do not have to be paid out in cash, such as depreciation and depletion, and having a reliable record of the tonnage production and ton-mileage in distribution which resulted from those expenses, it is a simple matter of long division to arrive at costs per ton, or per ton mile in the case of truck delivery.

We now have to take into consideration the administration and selling expenses which have to be met. They are fairly constant in amount and go on whether production is large or small. In budgeting and in quoting prices to secure business the producer must assume a tonnage production for the season proportionate to his capacity, say seventy-five or eighty per cent, and divide the totals of expected general overhead and selling expenses by that tonnage in order to get the amount per ton which must be added to production and distribution costs before any profit can come out of the selling price.

In the application of cost accounting which I have suggested to you today there is no possiblity of the cost accounting showing one result and the profit and loss account another, because each is a part of the other. There are no individual time reports and time summaries to be made because in the nature of the industry the labor works in crews and by making departmental groupings of the regular pay rolls in accordance with our ledger account classification, our pay roll sub-totals furnish the labor figure for our cost accounting. We have no use for material requisitions and reports for the reason that the only raw materials entering into production are the mineral deposits, which are taken care of by depletion entries at the end of each accounting period, based on the tonnage production records. One matter with which we are concerned, however, is the supplies inventory at the beginning and end of each period, which in many cases is important in amount and for which proper adjustment should be made. These are simple bookkeeping entries, however and involve no great labor or difficulty. The matter of burden distribution, which is the bugbear of most cost systems, is simple for your industry because practically all expenses except administrative and selling can be treated as direct departmental costs and become a part of the cost per ton. The reason for this, of course, is because, while your product may fall into various grades of sand or gravel, and sell for a variety of prices, the cost per ton are the same all the way through.

In this discussion I have purposely refrained from going into detail as to the classification of accounts or style of books and records desirable for your industry, because no two cases would have the same requirements. I have discussed general principles mainly and I will summarize all I have said in a few words:

First—The promotion of uniformity in accounting is one of the most important benefits you can get out of your trade association, primarily to put competition for business on the basis of knowledge rather than guess work.

Second—The general accounting system in your business can be made to furnish the benefits of a cost system, with slight additional labor or expense; merely a well thought-out arrangement of the accounts and the intelligent application of production records to the account results.

Very Much Improved

E. E. Klooz, general manager of the Portage Silica Company, of Youngstown, Ohio, writes: "In our opinion Pit and Quarry is very much improved. We have been very much interested in very many of the articles which have been published, and we also like the size better than the former one."

WISCONSIN'S 1928 CONCRETE HIGHWAY PROGRAM

By H. J. Kuelling
Wisconsin State Highway Engineer*

TRANSPORTATION has been the story of the ages. It has been the problem all through from the beginning of man. Civilization was almost and is today in direct proportion to its transportation. When they transported on the backs of men, later on the backs of animals, the people did not know much about those a thousand miles away or even ten miles away and as time went on and our steamboats and our railroads allowed us to meet with people further away, we have come to a stage where everybody travels. A man in the village thinks nothing of putting the family in his car and going 50 or 100 miles away and coming back to do the chores in the evening.

It was not economical with the old conditions to start in and pave a great system of highways. You never thought of starting out from Milwaukee and driving to Superior ten years ago. Now that it is possible to do so, our highways are improved by leaps and bounds and today the building of the highways, the product they want to use, is beyond the demand. Those users of the highways generally get what they want and they will get it because they are asking for what they are willing to pay.

The first highway work was done in 1907. In 1908 there were only four of us and there were only four of us for three years, the engineering staff that handled the entire work for the State of Wisconsin. Everybody knew how to build roads then and today there are a great many people who feel they know more about building roads than those who are spending their lives at it. In those days, we were merely crawling along. If we had a job on which some county was willing to spend a couple of thousand dollars, we thought we had a big job. I fully remember the day I came in from a county and reported to Mr. Hirst we had a $3000 job we were figuring doing the engineering on and he was very enthusiastic, but today we do not bat an eye at a half million dollars. So from that day we have ceased to crawl and in fact we are now where we will almost start to run to keep up with the demands of the users and payers for these highways. The highway movement in Wisconsin is independent of any individual or any group of individuals. It is something that is necessary.

International Highways Recommended

Those of you who read President Coolidge's message perhaps did not read the section I read so carefully. He put in a section advising the United States to assist her neighboring states in the construction of highways. He said, you have been giving them advice on military and other matters by allowing your military engineers and others to go to those countries and study their methods and give them the advantage of what we know in this coutry. Likewise we should now loan to those countries our highway engineers to enable them to build highways, fit and proper to build on to this country so that this highway movement which at first has gone beyond the county stage and the state stage and is now getting past the national stage and becoming international.

The Wisconsin highway problem was never so acute as it is today but it will never be solved. The highway movement in this state is going to go on because people will demand that they be served. The problem will never be solved because roads we think today are fine, big, wide boulevards will undoubtedly in the future be considered too narrow, too crooked or too heavy and there will be new roads demanded and built.

Snow Removal Problem

The urgent needs today and the problems we are trying to solve as a state department may be enumerated as follows: We have facing us first snow removal. If you live today in any of the northern counties, you keep your car in the garage. If you are in a town that has a street car you would not ride the street car because they are not running. The snow recently came with such terrific force that the northern part of the state is paralyzed because they have no facilities for removing the snow. I am not advocating that the state remove it but it is folly for one county to open up its roads and the next county not to and the third county do it. It is a state problem and the responsibility will be put somewhere, on the state or county, to keep open its highways. It is foolish for us to have millions of dollars invested in permanent roads and not be able to use them two to four months in a season.

Piece Meal Building

Another problem arises because Wisconsin tackled her problem differently from others. In my judgment, it will eventually be the best way. We started with piece meal system. If you look at a map showing the paved highways of Wisconsin, you will find it very spotted and many missing links. That is because the county has been the main unit through which this work has been done. One of our problems is to wake the people and connect the highways by building connecting links. Today you cannot drive from Milwaukee to La

*From an address before the Wisconsin Mineral Aggregate Association, December 8, 1927.

Crosse with the assurance you will not be stuck in the mud.

The third problem is the building of an entire skeleton system in the state; six or eight roads running each way across the state that can be maintained as all-weather roads. When that is coming, I do not know, but there is getting to be a greater demand for it. We hear something about it every day and people are getting enthusiastic. Just how it will be financed is a matter requiring legislation, but I am satisfied that it will be financed above the road work that we can do today. That is, it will not be substituting our present funds for building a skeleton system of through highways.

Dust Prevention Problem

Another problem is the matter of dust prevention in our highways. You do not like to go out and travel all day and eat dust, or drive through a lot of loose gravel because it is dangerous, dusty and your car slides. We are going to try and attack this problem and we hope to be in a position in 1928 to settle the dust on two or three thousand miles of highways. The other problem is making our highways safe to travel, which covers a great field of operations.

The next problem is our relationship to our neighboring states so far as highways are concerned. We cannot live within ourselves in highway construction any more than we can in manufacturing. State lines mean nothing except so far as government is concerned. If you want to travel to St. Louis, you travel along across Illinois and almost forget that you are traveling in another state. Wisconsin, however, is situated rather differently than a large number of states because we are seeking to make large sums of money out of our neighboring states, by means of our highways. The tourist business in this state is long past the stage of sentiment. It is a business proposition.

Our nearest estimates show that in the past year there was somewhere between $117,000,000 to $125,000,000 left by tourists from other states.

Future Expansion Plans

The state of Iowa today is planning to let 700 miles of pavement in 1928. The state of Minnesota is building a road on the west side of the Mississippi River. Why? Because they want to entice that river tourist business that leaves this little toll as it travels along their domain, so that they can make some of the business profits from them. I do not mean to intimate that we are going to lose all this tourist business but it is a cold blooded proposition for Wisconsin to hold as much as they can of the tourist business and to get as much more of it as they can. If they increase it to two million dollars, all the better, but it cannot be done as long as some of the tourists come up here and find places where they must be pulled out of a mud hole. So the tourist business is of great importance and being coveted for by our neighboring states. The states south of us come in here and want to spend money. Illinois with the city of Chicago, and Missouri with St. Louis and down through some of the other states, Ohio, have not the scenic attraction and rivers and so forth that we have.

Statistics on Usage

Now, you hear a good deal of talk about the fact that it was not economical to build some of our gravel roads. It is easy to sit down and figure out that it is cheaper to build a concrete than a gravel road over a period of years. In fact, I will cite you some figures I had compiled this year. I took a mile of each type of road and assumed the cost of gravel road $5,000 a mile for the surface. Assume the concrete at $22,000, the slab only. I started out with 500 vehicles a day on each road. I increased it to 8 or 10 per cent based on the increases that we have had in the past decade and was conservative. Then I took the maintenance cost of that mile per year, based on the United States government figures, then I took the interest on each cost and upkeep for each year and then I started in and from the government reports, computed the amount of gasoline used on each of those highways for a twenty year period. Then I computed the tire wear for twenty years on each of these two miles of highway and added them. With those assumptions I found that in a twenty year period the mile of gravel road had cost the traveling public $173,000 more than the mile of concrete.

Perhaps those figures are altogether too great because we were keeping down this dust proposition that will lower the gasoline cost. But nevertheless there is a difference in the two types when it comes to the economy of using them. The reason you and I and the general public doesn't grasp that thought is this, if I would have separated those figures into the interest cost on the construction and the maintenance cost there would not be anywhere near that difference, and that is the common way they do when people argue against the paved system of highways, they forget the indirect test, the gasoline extra-usage, the tire extra-usage which are the great differences in cost. You go down to the theatre and you pay a ten cent tax. You may think you are paying a tax but the average do not think of it as a tax at all, but if the city council should charge you ten per cent tax more on your property, why you would rise up and make an awful disturbance. So it is in using of the highways.

So then a difference in the two types of road is very great. That does not mean that the State of Wisconsin should start right in and quit building gravel roads. The highway builder cannot go out and do extravagant things—that is, extravagant on the face of them but perhaps economic on the long run, like the figures I quoted you on the gravel

and concrete road. I can sit down and show the legislature or anybody that from a few cold blooded figures it could be economical for us to go out and borrow $100,000,000 and build our system of highways in one year, but it cannot be done that way. We have not that amount of credit at our command, but gradually the prosperity of the state and the people that are using the highways are willing to pay for this better service.

The last legislature set up a large increase in our bridge fund. We are falling way behind in the amount of bridges we have to build—I mean large bridges over 300 foot in span. The whole fund was $250,000 and that was doubled making $500,000. In addition to that they have set up a special bridge fund of $400,000 for the use of the highway commission in assisting other states in building bridges and connecting our state with other states; also set up a fund like the highway crossings, $100,000, to be used in assisting railroads in separating grades.

Highway Budget

Our highway budget is set up as follows: All the money goes into one pot. There is $9,000,000 license fees, $6,000,000 a year in gasoline and almost $2,000,000 federal money which comes to Wisconsin. That makes a pot of a little bettetr than $17,000,000. That is divided as follows: First there is taken from it the cost of administration which runs over half a million dollars. Then is taken $100,000 of the highway commission. We have in addition to that $100,000 a certain percent of the maintenance funds. There is taken out of the maintenance fund $500 a mile for all permanent and federal highways, $400 for secondary highways and $1300 a mile for all remaining highways in the state. That takes something like four million dollars out of the pot. Then there is taken out the funds to assist the towns, villages, cities—every town gets at least $25 a mile for each road in the town.

The county trunk highway system is larger than our state trunk. There is over 12,000 miles as compared to 10,000 on our own state system.

The 1928 program I will cover in about one sentence. I find that the paving program is going to be probably 15 or 20 per cent smaller than 1927 owing to the fact that there were so many millions spent by the counties on bond issues. As near as I can figure now it will be slightly under three hundred miles of pavement.

The next thing I want to touch on is my pet hobby in concrete construction—that of quality concrete. We have been adopting a plain one, to two four mix or some other kind of concrete mix in building our roads, paying no attention to the quality or kind of goods.

We build a concrete road in Waukesha county and our material is of a certain character and we get a concrete road of certain strength. We go into some other section of the state, Wausau, and build a concrete road of the same identical proportions and get a concrete entirely different in tensile strength.

Conditions Vary

Traffic studies will tell us that certain roads in a certain community will need a paved road eight inches or ten inches thick or 800 pounds or 1000 pounds of concrete. In another portion of the state we will say we will build a seven or eight inch concrete of 500 pounds or 600 pounds or we may build one five inches thick or eight inches. We will study it out on a scientific basis and determine the thickness and strength that we should build. What is that going to mean? It is going to mean a number of things.

The future contractor must have scientific engineering assistance to fulfill his contract. If he will contract to build ten miles of concrete eight inches thick or 900 pounds tensile strength per square inch, he must know the economical way to do it. We will not care whether he goes to Southern Wisconsin or some other place and puts in a new kind of sand to mix with the sand he may have to get the very finest of aggregates to prove his strength. We do not care whether he improves his quality of cement; we do not care if he puts in some process or some ingredient into the concrete.

That is going to mean a problem for sand and gravel people, for many others and especially for the contractors. You must know whether your sand will require ten per cent less or 25 per cent more cement to produce a certain strength. That may sound strange, sand and gravel producers, but I want to tell you the time is here when that is going to be the basis on which engineers are going to design their public works.

No longer are we going to permit the building of roads that differ one hundred per cent in strength and quality. Some of you will agree with the American Society for Testing Material requirements on ordinary portland cement. Today there is not a cement made and shipped into Wisconsin that does not by far exceed the requirements of that Society, but those cements vary 25 to 40 per cent.

If you are going to build your pavement on a scientific basis; if you are required to build a pavement 500 pounds tensile strength and you can buy two for the same price, one of which will test 7 per cent greater in ten days, which one are you going to buy? We are going to take the good structure and the cement and sand and those that will produce the best strength and for the least money.

The future ahead of us will mean that we are going to go out on new work and I hope the Wisconsin Sand and Gravel people will help us. We cannot wait until everything is ready; we do not expect to do any large mileage on this scientific basis next year but we are going to start in some pavement and try and make some progress.

OIL ENGINE POWER UNITS

By J. W. Chadwick,
Ingersoll Rand Company*

POWER is an important item in the cost of making your product. Power is only produced in commercial work in two ways, by the flow of water and by the burning of fuel. Water power is familiar to all of you but it will hardly come into the discussion today. In the burning of fuel for power, that is something that was started about 200 years ago by a man named Newcomer and which finally developed into the modern steam engine. One of these engines was made for pumping water from coal mines and in that use it took the place of animal power or horses for pulling the tubs of water out of the mines. That is where the term horsepower came from. They found out in removing water from the mines by horses that they would pull 33,000 foot pounds per minute and the Newcomer engine was developed to take the place of horses on this type of work.

Now James Watt had occasion to do work with the Newcomer engine and in investigating the engine of how it worked he made a study of the losses of this engine, the heat losses, the power made from heat and he discovered mechanical defects and improved them and he has really evolved the modern steam engine, the reciprocating engine. About fifty years ago Dr. Otto invented the internal combustion engine, a four cycle engine exhibited at the World's Fair in Philadelphia in 1876. It had a horsepower of from 2 to 5 hp. It was considered quite a novelty because it didn't use steam and the fuel burned inside the cylinder instead of outside. That engine may have lacked something commercially at the time but at any rate today we have 750,000,000 hp. of these engines in use on the streets of the United States. It has been developed to a remarkable degree. It is used in airplanes, submarines, automobiles, portable engines and for such purposes as hoisting engines, air compressors and also on shovels as Mr. Mueller this morning told you about.

About thirty years ago Dr. Diesel of Germany, proposed a modification to the gasoline engine on internal combustion motor to make available to this engine a cheaper fuel. The gasoline engine which we call the Diesel engine was originally designed as a gas engine, but a gas engine and a gasoline engine are really the same because a gasoline engine has a gas making apparatus on it. Gasoline and gas being rather expensive, Dr. Diesel attempted to burn coal in the engine of that type. In order to admit coal into the cylinder of the engine he divided the coal, made Potter coal and was unsuccessful. In order to introduce coal into the cylinder he found that while mixing it with oil was a big improvement, it didn't get the results he wanted. I don't know his experiences along this line but he did not get satisfactory results at all until he abandoned coal entirely and used oil only and as soon as he made an engine run with oil only he got results. In about 1897 the first practical engine was made of this type and the tests of the engine showed such a high thermal efficiency that its use was warranted in other countries besides Germany and he licensed various builders to build this engine including the Busch's in the United States. It happened that the Busch interests built the first engine put on commercial loading. That was in 1898. I think that was a 50 hp. engine and is still in existence in St. Louis. They built a great many of these engines and had some difficulty in introducing the engine into use in this country due to the fact that coal was very cheap in the United States, especially at that time. I suppose in those days it was $1.50 per ton delivered. Well, if oil was worth its present price or half its present price the thermal efficiency of the engine would not be of such great consequence in the cost of power.

Nevertheless in the face of these obstacles, the Busch interests succeeded in installing a great many plants throughout the country, at least one plant in each state in the Union. In the course of time, in 1912 or around about that time the patents on the Diesel Engines ran out and other builders started building Diesel engines, so from that time on the Busch interests had competition but this was better for them for with the cooperation of the other builders they received a great deal of help in fighting battles for the Diesel engine.

The progress of the Diesel engine since the patents expired has been very satisfactory. They have been built now for thirty years and 97 per cent of the engines installed are still in service.

The present uses of the engine will be of interest to you. They have been put to almost every use today an engine can be applied as power. The first thing that occurs to me is their use in shipping. One half of the shipping in the world is being powered with Diesel engines. The ship owner uses Diesel engines, not because he likes Diesel engines but the operation of ships is something like the conduct of our business, the man who can operate at the lowest cost can get the business at the lowest profit and can therefore increase his volume. Some ships are gradually going out of use but one-half of the power installed in ships now is of the Diesel engine type. Some ships use as much as 20,000 hp. in one ship, that is 25,000 tons displace-

*Presented Before the Wisconsin Mineral and Aggregate Association, December 8, 1927.

ment. Some of our largest ships use oil engines for power.

The next great use for Diesel engines is in the pumping of oil. Our country is covered with oil pumping pipe lines. The longest single transit system runs from Caspar, Wyoming to Kansas City, 1,000 miles long and from Kansas City to Wood River, Ill., and then to Whiting, Indiana. Lines are then connected from there east to New York City.

Fifteen years ago every station on this line was steam driven with high grade steam operating equipment. That run contains a triple expansion engine. Nowadays they are equipped with Diesel engines. Each station is equipped with engines running in horsepower from three hundred to five hundred. Oil engines are not used in these stations. The fact of the matter is the fuel oil is not taken from the pipe line but is shipped in in tank cars. The reason for that is that the oil in the pipe lines is too valuable to use for fuel purposes. It is crude oil after it leaves the ground and contains gasoline, kerosene and lubricating oil and all the various by-products made from this oil in refinement. The valuable products are made and the residium is shipped back to the pumping station for fuel. The engines are operated on the shipping fuel shipped back rather than the oil that goes through the lines. At this point it is fair to notice another of the reasons for the use of oil engines for pumping oil. A pipe line 1,000 miles long and 10 inches in diameter may handle as much as 40,000 barrels of oil a day. The pipe line itself is worth a great deal of money. The oil refinery at the end of the pipe line is sometimes worth millions of dollars. The interruption of these lines is very expensive.

There are pipe lines in other parts of the United States, running from the Gulf district up into Oklahome and east again. I haven't figures here as to how many horsepower they use for this purpose but suffice to say its biggest use is for oil and the shipping industry.

Another use is for power stations, for central station use. In using it for power in points like Milwaukee or Chicago where there is a great amount of power generated, it is very expensive and coal is a better means but in the small stations it is very practical.

Another use of a great amount of oil engine power is the cement plant. A cement plant can be operated by steam to very good advantage for the reason that heat is a waste product in a cement plant. In some ways the cement plant can be compared to the manufacturing operations conducted on crushed rock. They both use a lot of power. I have in mind the San Antonio Cement Co. which uses 4,000 oil engines—for producing power.

One user in Milwaukee of a 100 hp. is said to operate eight hours for the price of the same load being hauled for one hour by steam. That is the users statement but I believe a ratio of 4 to 1 is correct.

If you have a 100 hp. load and want to haul it with an oil engine it should be belted to an oil engine rather than through the motor or generator. It costs more money to buy and 25 per cent more to operate so the plant considering the use of oil and expense would do well to consider the design of plant so that the engine can be used most economically. Flour mills operate this and save a 5 per cent loss which is a considerable item in the cost of flour.

Another use for oil engines is for operating a locomotive. I believe three years ago the use of oil engines for operating locomotives was on paper only. At the present time there are a considerable number of Diesel engines in use. There are three in Chicago. They are 60 tons each. They are not small in any sense of the word. These 60 ton engines recently pulled cars on a test of nearly a mile long. These 92 cars weigh 4500 tons. I haven't the exact figures on that but I believe it is 600 tons to each gallon of oil. These 60 ton engines recently ran from Schenectady, N. Y. to Chicago on a fuel expense which amounts to less per mile than the ordinary sized motor car for the same distance. That is 2½ gallons of gas to 5 cents of oil. They were put in primarily because they were smokeless. In car service it saves money. These three have been in use in Chicago over a year and a half or two years by count and they have saved $1,400 per month in fixed charges.

So much for oil replacing steam. One of the big reasons that oil is being used is it is more economical. Small steam plants below 500 hp. have a thermal efficiency of 3 to 5 per cent. Large steam engines up to 1,000 hp., 8 to 10 per cent thermal efficiency. Ordinary gas engines have an efficiency of 20 to 25 per cent. That is the reason you can take high priced gasoline and compete with low priced power such as shovel or trucking.

The Diesel engine has the highest efficiency known from 30 to 33 per cent. Now the next thing is to find out what this efficiency will do for you. These figures I have given you while accurate, don't mean anything to you. The only way you will know is what it will cost you to run your plant with a Diesel engine as compared with a steam engine or electric power. That will take a lot of careful study to find out. Sometimes the economies are well worth while. I have already given you reasons as to why these other industries use oil engines. They are attracted by this economy. Also oil engines are cleaner in that they don't produce any ashes. In your own work you might find economies that would be worth your while.

PRODUCER AND CARRIER RELATIONSHIP

By J. L. Brown,
General Superintendent of Transportation, C. M. & St. P. R. R.*

THIS subject is rather difficult to discuss because in this period of progress everyone realizes that producers and carriers are as inseparably connected as "ham and eggs" or any other of those combinations with which the public is familiar. They just naturally go together.

No one can imagine a producer of any commodity setting himself out in business and hanging out his shingle in a locality not served by a railroad. The only business that I know of that takes to the woods is the lumbering industry. However, even that one finds it necessary to have rails extending into its fields of operation so that the great logs can be moved to the mills and the lumber thence to the market. For these reasons we are both vitally interested in the other's welfare and I am pleased to acknowledge right here that railroads are just as dependent upon producers as are the producers upon the railroads. In the last few years relations have become exceedingly close and cooperative and satisfactory. Special efforts have been made by the railroads to see that the right kind of cars were supplied at the right place and at the right time. On the other hand shippers and consignees are aiding materially by prompt loading and unloading of equipment.

I presume you are all familiar with the fact that the number of cars owned by a railroad is not the sole factor that determines whether or not it can promptly supply orders for equipment. The prompt loading and unloading of equipment is one important factor. Another equally important factor is adequate yard facilities at terminals to insure prompt switching of cars and to avoid delays by congestion; sufficient side and passing tracks along the road to permit free movement of trains; the right kind of motive power, of course, and the cooperation of all railroad employees and the shipping public. A railroad might have an adequate number of freight cars, but by failure in one or more of these other features it might be unable to avoid the effect of what is called a "car shortage."

As you know, the operations of the Milwaukee in recent years have not brought adequate financial return. Regardless of this important fact, its service has not been permitted to deteriorate, and to be more specific, in the thirty months ending June, 1927, it had constructed or contracted $15,000,000 worth of rolling stock and had expended for other equipment over $4,000,000—for shops and engine-houses including machinery, $1,750,000; for heavier rail and additional tracks $4,500,000 and for other improvements of road $7,000,000. The total of these items is over $32,000,000. It has replaced 12 trains necessary to make up its Pioneer Limited and Olympian with new equipment throughout and has fitted all the cars in these new trains with roller bearings with large additional first cost. It has built new freight assembling and distribution yards, has extended its line for short distances into sections needing transportation service. It has opened a new entrance to Yellowstone Park called the Gallatin Gateway and built at that entrance an inn as attractively furnished as any public building to be found in the West.

I mention these to indicate our desire to improve our service and relations with the public.

Railroads Main Carriers

In recent months the public has been urged to become what is termed "air-minded" meaning that it should seriously consider the use of air carriers for passenger, express and freight business. For some years the use of motor vehicle has been developing tremendously. Naturally railroad men do not like to see other agencies taking business that the railroads need to build up their inadequate revenue. However, there is no disposition on the part of railroad executives to complain about the loss of traffic that other agencies can handle more successfully. While we believe a great deal of business is moving over the highways under the mistaken idea that that form of transportation is cheaper, it is doubtless true that in some instances there are other considerations that in the shippers' mind effect the differences in cost.

So far as air carriers are concerned, the difference in transportation cost is still greater and there seems to be no likelihood that in the future the volume of business moved by airplanes will seriously affect rail movements.

Admitting a place in the scheme of things for highway and airway transportation, none of us can afford to lose sight of the fact that the main carrier of the Nation's business, as far as can now be seen, always will be the railroad system.

I do not make this assertion merely because I am in the railway business, but because careful consideration of the qualifications of other forms of transportation now existing, with the improvements and developments contemplated by men connected with these agencies, gives assurance that the railroad has nothing to fear from competition in the field of low price transportation.

The relationship between producer and carrier requires that consideration be given to these important facts which is brought out in a striking

*Presented Before the Wisconsin Mineral Aggregate Association, December 8, 1927.

manner by the little colored poster which has been handed to you today. When you get an opportunity I would appreciate your studying these posters and in view of these facts you may pardon the suggestion that the public may well continue to be "rail minded" until further notice.

You may be interested in the statement that last year the Milwaukee Railroad handled about five and one-quarter million tons of clay, gravel, sand and stone. This was about 10 per cent of our total tonnage and we are glad to have the business.

Regional Advisory Boards

In the relationship between producer and carrier, there have been established, as some of you apparently know, Regional Advisory Boards which are a voluntary organization of all branches of the public in the territory of each board's jurisdiction, usually covering from three to six States, and which territory, as a practical matter, is made to coincide with the territory of the several district managers of the car service division of the American Railway Association. The boards are composed of representatives of the production, distribution, consumption and credit (as related to transportation of commodities) of each district. The personnel of the board itself consists of:

(a) Its officers.

(b) The chairman and vice chairman of the commodity committees.

(c) Members at large.

An executive committee usually exists, functioning between sessions of the board. As many commodity committees are established as are deemed necessary to make the board thoroughly representative of the district. Each commodity committee deals with a committee of the carriers at any time when the necessity arises, and need not await a meeting of the board itself.

The regional advisory boards function for their territory on all matters which come within the purview of the car service division of the American Railway Association. It is a "service" organization, and there are no restrictions on what may be considered by the board, or its committees, if they come within these limitations. They do not deal with rates. We may summarize their activities by saying that they cooperate with the railroads and the car service division on car supply and service matters as outlined by the seven basis points upon which they are predicated and are enumerated below:

1. To form a common meeting ground between the shippers, local railroad, and the carriers as a whole as represented by the car service division, for the better mutual understanding of local and general transportation requirements, and to analyze transportation needs in each territory, and to assist in anticipating car requirements.

2. To study production, markets, distribution and trade channels of the commodities local to each district with a view of effecting improvements in trade practices when related to transportation, and promoting a more even distribution of commodities where practicable.

3. To promote car and operating efficiency in connection with maximum loading and in the proper handling of cars by shippers and railroads.

4. To secure a proper understanding by the railroads of the transportation needs of shippers, that their regulations may fit shippers' requirements, and, contrary, to secure understanding by the shippers and their cooperation in carrying out necessary rules governing car handling and car distribution.

5. To acquaint shippers and railroads in each section of the country of the seasonal requirements in their section, in order to promote intelligent cooperation in the handling of equipment between the different districts of the country.

6. To adjust informally car difficulties which may arise in each local territory between the carrier and shipper.

7. To give the shipping public a direct voice in the activities of the car service division on all matters of mutual concern.

As a result of the study of business conditions by the several board committees and their reports at each meeting, the railroads and the public have been given a constant and better insight to their responsibilities. In addition to analyzing the different factors of production and markets, and their accomplishments toward evening out the volume of distribution, the committee submit, at periodical board meetings an analysis of their future transportation requirements in each district. Furthermore, in cooperation with the railroads in each district, the different commodity committees are effecting a complete understanding of the necessary rules governing car handling in order to promote a constant uniform flow of equipment between the different territories of the country to meet current demands, and to avoid, as far as possible, the handling of equipment by specific orders. Car efficiency as related to the prompt loading, prompt releasing and the heavier loading of equipment is also being carried on by the boards in their respective districts.

Physical Properties of Slate

Work is in progress on the physical characteristics of the various slate deposits in the United States by the Bureau of Standards. Samples have been received from a considerable number of the producing quarries and testing is well under way. The data will form the basis of a report similar to that on page 81 for commercial limestones.

CEMENT AND MASONRY CONSTRUCTION STUDIES BY BUREAU OF STANDARDS DURING 1927

INVESTIGATIONS dealing with cement and masonry construction of a broad practical value have been made during 1927 by the Bureau of Standards. The following summary of this work is published with the approval of the Director of the Bureau of Standards.

Fabricating and Curing Conditions

Due to the influence of temperature and humidity on the strength of mortar and concrete test specimens during fabrication and storage it is necessary to control the fabricating and storage conditions. An automatically controlled cabinet has been built and placed in operation at the Bureau for the storage at 70 degrees F., and as high a humidity as practical, of cement and mortar test specimens for the first 24 hours after molding. An apparatus patterned after the Beaver control operates a commercial type electrical refrigerating unit and a nicrome heating element, placing each in circuit when needed. Water is constantly circulated within the cabinet, being fed from the circulating pump through pipes to the top of the box, from which it flows down fine mesh screens to the sump formed by the bottom of the box. The air within the cabinet is also circulated, and wet and dry bulb recording thermometers make continuous records for temperature and humidity. The operation of the apparatus is satisfactory.

Equipment has also been installed to maintain constant temperature in the concrete mixing laboratory and in the damp storage room for curing concrete test specimens. In the future the concrete materials will be at 70 degrees F. when used and the specimens will be made and aged in the molds for 24 hours at this temperature. The damp storage room will also be maintained at this temperature.

Aggregates for Concrete

The increase in allowable working stresses, and the rapidity of construction procedure make it important that the concrete placed in a structure be of the design strength. It is also very desirable that the strength to be developed by a given aggregate in any proportion may be known within reasonable limits either from seven day or shorter age tests, or simply from the grading and other characteristics of the aggregates. An extensive study has been made of the effects of different cements, different types of aggregates, proportions of materials, gradation of coarse aggregates, the ratio of fine to coarse aggregate, on the strength of concrete; also the relation of the earlier strengths of concrete to the 28 day and later age strengths. The results of these tests are being tabulated and analyzed. Several points of interest have been established. It was observed that, for the same amounts of water and cement, and the same proportion and quantities of aggregate, some of the cements produced a concrete of relatively greater workability than others. The relative normal consistency of the cements did not account for the difference in workability of the concrete. The workability was judged both by the laboratory mixers and by the operator who rodded the concrete into the molds.

The tests indicate that the strengths of the concretes made of the several cements used at ages up to and including 28 days vary considerably, but at six months and one year (beyond which age the tests have not been carried) the strengths are more nearly equal for the several cements. The tests also indicate the desirability of using a ratio for fine to coarse aggregate between 1 to 1 and 1 to 2, in order to obtain maximum strength and workability, preferably nearer the higher ratio in the case of coarse aggregates deficient in the smaller sizes.

Durability of Concrete Aggregates

One of the most important of the properties of concrete aggregates, which up to the present time has been subject to the least experimental investigation, is the durability of the aggregate before making into concrete. The direct method of determining the durability of the aggregate by freezing and thawing cycles is long and tedious. To obtain a quicker test two accelerated weathering tests have been developed the sodium sulphate and the sodium chloride tests. The Bureau has undertaken an investigation of these accelerated weathering tests to determine whether they have any relation to the freezing and thawing test. From some information available it seemed desirable to add another form of accelerated test—boiling and drying. The tests are all now in progress and although most of the aggregates are sound and durable, some have disintegrated.

Cement Pastes and Concrete Mixtures

Means of measuring the workability of cement pastes and concrete mixtures have been experimentally studied during the year. To date there has been no acceptable method of measuring the workability of a mix other than by the judgment of a skilled operator. Those hitherto employed—the slump cone, the flow table, the penetration test—are all satisfactory to a certain degree, but two mixes giving the same measurement on these machines may have very different workabilities as

judged by skilled operators. A new apparatus has been developed in conjunction with the Celite Products Company Associateship at the Bureau consisting of a flexible hollow metal cylinder, which when filled with the concrete whose workability is to be measured, is compacted by a number of impacts on the flow table, and then compressed in the direction perpendicular to the axis. The apparatus is as yet in the experimental stage, but test results from it show less variation in measured values than with the apparatus previously used.

Standard Methods of Physical Tests for Cements

An investigation of the volumetric changes of portland cement after mixing, with the object of comparing these changes with the soundness of cement, has been concluded. The measured volume changes for 32 brands of cement ranged from almost nothing to an expansion of .061 per cent, using the correct amount of water for normal consistency as now accepted, and also using 42 per cent of water by weight of dry cement. The usual soundness test requirements were met by all of these cements. The problem of developing more satisfactory physical tests for the acceptance of portland cement is being studied. The present tests, especially for tensile strength, do not appear to be correlated with the relative strengths that these same cements will develop in a concrete and it is desirable to develop a simple test to obtain this correlation.

Constitution of Portland Cement

In addition to the studies of cement conducted in co-operation with the Portland Cement Association, work has been conducted on the study of the heat of reaction of portland cement with water and on studies of the hydration of the aluminates of lime. Sufficient data were obtained to indicate that the interesting feature of the reaction will be in the first twelve hours and it appears that much simpler equipment can be used and at least relative values obtained. This is now being done.

Former investigations have shown that lime can combine with alumina only in the molecular proportions: $3CaO.5Al_2O_3$, $CaO.Al_2O_3$, $5CaO.3Al_2O_3$, $3CaO.Al_2O_3$. Tricalcium aluminate appears to be the only aluminate present in portland cement of normal composition and normal properties. The monocalcium aluminate and the 3:5 calcium aluminate occur in cements characterized by a high alumina content.

An investigation has been undertaken to obtain more information on the mechanism of the reaction of water on the calcium aluminates. Some preliminary experiments had indicated that the cementing qualities of the calcium aluminates and high alumina cement might be closely related to their reaction with water in the formation of metastable and supersaturated solutions of calcium aluminates. It was decided, therefore, to study not only the chemical composition and pH of these solutions as they were formed in the early periods of the setting process, but also to follow the changes which they underwent in passing from a metastable condition to one of equilibrium. Since the addition of water to freshly prepared tricalcium aluminate, $3CaO.Al_2O_3$, produces a very vigorous reaction, the changes in composition of the resulting solutions could not be followed in the case of this aluminate. Previous investigations have indicated that its setting is due to the formation of hydrated tricalcium aluminate.

It was surprising to find that the other anhydrous calcium aluminates and a high alumina cement, differing so widely in chemical composition, reacted with water in the early periods of the setting processes to form calcium aluminate solutions with the molar ratio of CaO/Al_2O_3 in each case very close to 1.0. The concentration of this monocalcium aluminate solution increased with time until a maximum was reached. Part of the lime and alumina precipitated from these metastable solutions, at first rapidly, and then more slowly as time went on. At the later periods the molecular ratio of CaO/Al_2O_3 remaining in solution had increased with an increase in the pH.

Chemical analysis and petrographic examination of the material precipitated from the metastable solutions indicated that hydrated alumina and hydrated tricalcium aluminate were precipitated as equilibrium was approached. Calculations based upon electrometric measurements indicate that the aluminate in solution is the calcium salt of monobasic aluminic acid.

It would appear that the cementing properties of the monocalcium aluminate, the 3:5 aluminate, the 5:3 aluminate, and the high alumina cement studied were in part due to the precipitation of hydrated alumina and crystalline hydrated tricalcium aluminate from a metastable and supersaturated moncalcium aluminate solution.

Terra Cotta Wall Investigation

In co-operation with the National Terra Cotta Society, the Bureau is conducting an investigation of methods of attaching architectural terra cotta to concrete and brick masonry. Present methods differ widely and no comprehensive study has been made to determine the most suitable practice. In some localities metal ties and fixtures alone are used to support terra cotta, while in others the additional support of some form of masonry bond is though essential. In this investigation the resistance of different types of construction to loads is being determined.

Walls representing some of the types of construction used commercially were built in the laboratory and subjected to certain conditions of loading which may occur in buildings. As the loads were

applied observations were made of the displacement of the terra cotta and of the deformations and cracking of the walls. In the tests the facings anchored by both metal ties and by a masonry bond resisted greater loads than those anchored by metal fixtures alone. The comparatively rigid attachment afforded by a masonry bond did not appear to be an objectionable feature as might have been supposed, even when the backing walls were subjected to loads much greater than would be expected in building.

Experimental Concrete Mine Stoppings

The Bureau of Standards co-operating with the Bureau of Mines conducted an investigation of the resistance of concrete mine stoppings to pressures suddenly produced by explosions. Stoppings are built in mines to prevent flames and other destructive effects of explosions from spreading throughout an entire mine and for sealing abondoned galleries. Data on the effects of explosive pressures were obtained by testing twelve experimental stoppings.

An explosion chamber of concrete, heavily reinforced, was constructed as part of the test equipment. One side of this chamber was open and was fitted to receive a test stopping which could be sealed in place to form a closed chamber. In making a test a stopping was subjected first to air pressures, slowly applied, and then to a series of pressures of increasing intensity produced by the explosion of charges of black powder, until failure occurred. As the pressures were applied measurements were made of the intensity of the pressures and of the deflection of the slabs. A report on the investigation was submitted to the Bureau of Mines and the data obtained served as a basis for recommending methods of design.

Hollow Tile and Concrete Floor Slabs

Investigations on the strength of combination hollow tile and concrete ribbed floor construction have been continued. Since 1924 the Bureau has been co-operating with the Hollow Building Tile Association in a study to determine the structural value of hollow tile in such construction and to obtain data useful in the preparation of standards and specifications for floor tile. Specimens in the form of beams were built to represent portions of floor slabs and were tested to failure. The first series of these tests was reported in Technologic Paper No. 291. Another series in which 60 beams were tested has now been completed.

The data from the second series give information on the assistance of the tiles in resisting stresses and on the relative value of tiles of different design. The tiles added materially to the shearing resistance of the beams, the assistance being dependent chiefly upon the strength and the thickness of the shells bonded to the concrete.

(*Continued from page 48*)

thawing throughout our country and their strength strong enough for cartridge usage with gelatins formerly employed. The use of Ammonium Nitrate allows a choice of granulation of this salt and since the granulation controls in great measure the velocity of the powder resulting, numerous combinations of velocity and strength of this type are possible. Experience has shown, however, that possibly three such combinations will cover the entire field. The granulation of the Ammonium Nitrate also controls the number of cartridges to the case and it is possible to provide grades of this type ranging from 115 to 180 1¼x 8 inch cartridges to the case. From this it will appear that this type permits of still greater economy than the gelatins. Experience has shown that 40 per cent economy is not too great to expect from their use. With their positive sensitiveness and with their cartridges properly prepared to withstand storage, these grades that have been tried have shown great merit.

These two new series of explosives have been outstanding developments during the past two years. They have passed through exhaustive field tests during this period and have been found to function as herein indicated and as more economical blasting agents they should merit interest and personal study by pit and quarry operators.

Home Building in 1927

New quarters for 95,448 families were provided in apartment houses planned for construction during the first six months of 1927 in principal cities of the United States, according to an investigation just concluded by the United States Department of Labor. To house 57,899 families, single dwellings were planned in the same period and in the same cities. Double houses were projected to shelter 24,204 families.

Provision thus was made for new quarters for a total of 177,551 families. Of the total residential space 53.8 per cent was in apartment houses against 32.6 per cent in single dwellings and 13.6 per cent in double dwellings. These proportions indicate the extent to which residential construction in the United States is tending in the direction of the apartment structure and away from the single home structure. In the first six months of 1922 the proportions were apartment houses 34.6 per cent, single dwellings 43.4 per cent, and double houses 22 per cent. The labor department's data are based on building permits issued to eighty cities.

New Georgia Plant

The Georgia Lime Rock Company of Perry, Georgia, has acquired about 300 acres in the vicinity of Perry and will build a crushed stone and lime plant. The anticipated daily capacity will be 40 cars.

POWER SHOVELS

By Geo. H. Mueller,
Koehring Company*

OWING to the time available to discuss this very extensive subject of power shovels, and as the range of sizes of shovels generally used is from one-half yard to one and one-half yard dipper capacities and also, since the tendency of the times is to use the caterpillar type, gasoline, electric, gas-electric and gas-air driven machines, I am going to confine my remarks to this size and kind.

By power shovel is meant the self-contained unit which works under its own power and which has the operating functions of digging, hoisting, swinging and traveling.

Generally speaking, all power shovels of recent manufacture have common fundamental characteristics in their design and construction but differ in their details and the application of the power to secure their various actions.

Some twenty years ago the power shovel made its first appearance and was a steam driven outfit on which all the power was obtained from a single engine and this power was applied to the various movements by power transmission machinery consisting of shafting, gears, belts, chains, friction clutches, etc.

Judged by the models of today, these early shovels were crude in design, clumsy, slow and generally inefficient.

Then came the steam shovel with its separate engines for producing and controlling the separate actions of the machine, which arrangement with improvements from time to time, has proven very successful up to the present day.

It has only been during the last eight or nine years that electric and especially gasoline powered shovels have been put on the market and developed to their present high standard of efficiency and this can be attributed to the great advancement made in the design and construction of electric and gasoline motors during that time. In short, the gas age in which we are living has been responsible for this great change in the motive power on power shovels.

Some "dyed in the wool" steam shovel users still believe that the gas and electric shovels are still in their experimental stage and while it must be admitted that improvements are being made in keeping with the progress of the times, and will continue so, the very fact that all of the old shovel manufacturers and as many more new ones, are now producing gas or electric shovels, should be sufficient evidence to convince the most skeptical that these shovels are in demand and must be proving successful.

Shovels Fundamentally Similar

A comparison of the design and construction of steam and gas or electric shovels will disclose that fundamentally they are very much alike and the difference lies entirely in the kind of power and how it is applied to the various operating mechanisms and parts. It is very evident that all shovels must have some sort of wheel or caterpillar type traction, under car-body, bull swing gear, turntable, revolving platform, or cab, boom, dipper, dipper sticks, boom and dipper hoisting mechanism, crowding and racking in mechanism, swinging and propelling mechanisms, etc., to make up a piece of equipment of this kind and these parts comprise by far the greater part of the whole shovel.

Therefore it is natural to assume—and it is a fact—that when the manufacturers began to produce the modern gas or electric shovels, they took full advantage of the experience gained in building this kind of equipment previously and applied the best there was in the old products to the design and construction of these modern shovels.

Details Vary Greatly

However, the details in design and construction of various makes of shovels as well as the manner in which the power is transmitted to produce the necessary operations vary greatly and it is in these features that various manufacturers claim superiority for their products and which mean so much to the success or failure of them.

With so many good shovels on the market today, it is quite a problem for the user to decide on what make and type of powered shovel to secure to meet his particular requirements but the question of size is more easily determined.

The size of the shovel will depend upon the nature and size of material to be handled, the climatic and general working conditions under which the shovel will operate, the yardage to be handled in a given time and last but not least, the efficiency of the operator.

Where boulders or large pieces of rock are to be handled, the size and shape of the dipper must be given first consideration and be proportioned accordingly. Then its capacity and the other elements effecting the shovel performance must be given consideration.

From the standpoint of the shovel itself, the dipper alone is not the gauge of the shovel capacity for this capacity depends also on the power of

*Presented Before the Wisconsin Mineral Aggregate Association, December 8, 1927.

the shovel, its hoisting, crowding, swinging, and traveling speeds, ease of operation and again the efficiency of the operator.

Nature of Material

Next to consider, is the nature of the material to be handled and general working conditions.

It is self evident that a shovel working in easy digging in high banks will produce more yardage than where hard digging in shallow cuts is encountered. Then again, the height of discharge to be accommodated, the amount of swing required whether the shovel is on casting or spot work, and grades or slopes that are to be maintained, also effect the capacity. In short the same shovel on different classes of work and operating under different conditions may produce a variation in its yardage capacity of 500 per cent, for while a shovel may have a maximum working speed of from 3 to 6 dippers per minute, the average working speed may drop down to from one to three dippers per minute.

But there is one certainty about the capacity of any shovel, no matter how fast it may be or the amount of power on it, and that is its hoisting or digging capacity is limited by its ability to withstand over-turning, for no shovel can put more effort to work at the digging end than it can counterbalance at the opposite end.

The kind of power to use on a shovel depends to a great extent on the operating and climatic conditions, whether or not electric current is available and what it costs.

Considering Power Cost

Where a shovel has to travel over considerable distance, the kind which generates its own power usually proves the most efficient but where the shovel remains more or less in one place, the electric driven shovel, receiving its current from some outside source should receive special consideration along with the shovels of the other types for it may prove more economical from power cost standpoint and have other advantages such as ease in starting, especially in cold weather, capacity to stand overload without stalling, no costs for handling fuel or water, and the convenience attendant thereto. But it must be borne in mind that where the supply of current is not constant or regular, long delays may occur which are beyond the ability of the operator to eliminate.

No matter what kind of power is used on a shovel or how it is transmitted to produce its various movements, it must be, first, sufficient to exert enough pull on the dipper to begin to tip up the shovel when the boom is at the normal working angle of 45 degrees and the dipper is picking up its load at a point directly under the end of the boom.

Second, the power must be sufficient to propel the shovel at least at its slowest traveling speed if it has more than one speed, up inclines of at least 30 per cent where the trade traveled over is fairly firm and smooth.

Sufficient Power Necessary

In going into this subject I found it was going to be a lengthy one so I will make my talk more or less extemporaneous. The third item to be considered in connection with power shovels is that the shovel must have sufficient power to do both the hoisting and swinging. In other words when the dipper is coming up through the cup there must be no slowing down when it begins to swing. Where gas power is used it is always safe to secure a motor with a lot of reserve power. If however the gas engine has been in service for sometime it becomes less efficient from a power standpoint so reserve power in this line is very vital. Motors in this line of shovels that have speed of 500 to 1,000 r.p.m. there is a loss of power and that means a short life to that piece of machinery. The Diesel engine has been up for consideration for a number of years but unfortunately so far they have not been able to find to my knowledge an engine that will stand up the way our gas engines do. A lot of expense is incurred in putting on a Diesel engine but we are hoping in the next few years an engine of this type will be produced because of the economy of that engine from a fuel standpoint.

There are some shovels on the market that generate their own power electrically perfected. There is a generator that generates electricity conveying the power to the units of the shovel. We have an air machine also that compresses air instead of using power direct to the various mechanisms and the air is used on this machine just as steam has been used on some shovels, electric motors on the outside. When you get into a place where the current has been brought in from the outside there is a tendency to overload these motors. Bear in mind however that every power machine means tipping from the machine so that you are absolutely limited to the type of work.

So much for general remarks on power plants. Ample power has a great deal to do with the success or failure of the machine. It may have ample power but slow on speeds, hoisting crew, pushing out, swinging and travel speeds. So in considering a shovel your speed must be born in mind. On the traveling speed there are a great many shovels which have two speeds and that I think is preferable because it gives you a chance to work fast if you have to travel over a long distance and often.

The controls of course should be conveniently located so that the operator has good vision of his contact at all times and it is the idea of most manufacturers to have the location of the controls so that your operator can handle all controls without leaving his seat.

Selecting the Machine

Getting down to selecting the make of a machine, why of course the first thing to do is to look up your reliable manufacturers who have been building machines for years and are thoroughly dependable from a financial standpoint as well as building and service and in selecting a machine your mechanical phases are of course the first thing to look into, the build, a good capacity, the speed, etc. I recommend a six caterpillar construction. If everything is all right and your caterpillar of no account and can't move it means you can't get much out of your machine and particularly around a sand and gravel plant so the first thing to look into in the construction of a shovel would be the design of caterpillar and if it would withstand cracker action, that is sand, stone and gravel getting into the mechanism and in being knocked to pieces. A great many caterpillar treads eliminate the possibility of the crushing possibility in the design. Then again the design of tumblers should be such as to eliminate the possibility of cracker action. This wasn't taken into consideration years ago but the present design has gone through the fact of the breakage and tried to eliminate it. On a shovel, on the lower part of it a very important feature to look into is the amount of machinery in the carrying body. If there is a lot of machinery under the machine the operator isn't going to give it proper attention. That machinery should be on the upper deck where he can get at it. With most of the machinery underneath attention should be given to clearances of that machine for when it mires in dirt, there is considerable difficulty, and obstruction.

Then we come to the car body and the base of it on which the machinery is mounted. This should be a strong piece of equipment because it is the foundation of the whole machinery and is generally made of one big casting for the reason that while rivetted structures have strength, there is more or less of a tendency of their coming loose.

The anchorage and bull gear of your car body is very important for the reason that the shovel is swinging constantly and if your bull gear is not anchored securely to the car body it means it will work loose and cause a lot of expense.

The ability to move the swing pinion is important for no matter how big the gear may be it must be operated so that little pinion is taking a lot of shock and is going to wear out much sooner than the gear and the ability to remove that swinging pinion is an important matter.

Then there is the question of drive. The center pin feature on a shovel is a very important one for the reason that it has to take so much of the stress of overturning as well as shearing by pushing back and forth and the size and design should be looked into very thoroughly.

As a rule the power for driving the caterpillar goes down to the center pin and its driving shaft must be of good size and the center pin so designed there will be no cramped action when swinging.

Then we come up above to the swinging deck. Here is another part of the machine that has got to be pretty stiff throughout and the tendency is to make that part of the equipment a steel casting. Then we come to the boom. That is a very important feature on the shovel. It has so much twisting and racking to it that even if properly designed the rivets become loose and it is a very expensive item to renew.

The design of the dipper sticks is important. The dipper should be easy to repair and the lips and the teeth adjustable to accommodate light cutting and heavy cutting.

Going back to the racking action in a shovel, any shovel that is not equipped in this manner is impractical. In other words your machine must be so designed as to be able to crowd the dipper out or it is impossible to haul grades and slopes. The maximum of actual dipper swing is one of serious consideration and consideration should be given the kind and size of drums as to whether or not the drums are grooved so that cables won't pile up on themselves.

Cement Clinker and Alite

The American investigators of the Bureau of Standards do not believe that cement clinker is essentially a synthetic mineral called Alite, but that it consists of a mixture of free tricalcium silicate, free dicalcium silicate and free tricalcium silicate. Jaenecke assumes, from his own investigations, the existence of a compound $8CaO.\ 2SiO_2.\ Al_2O_3$ (Jaeneckite) and considers this identical with Alite. Kühl thinks the existence of Jaeneckite is probable but does not believe it to be identical with Alite. Nachen and Dyckerhoff believe Alite to be a dicalcium silicate containing up to 10 per cent free lime and perhaps other substances in solid solution. This theory satisfies the mineralogical structure of cement clinker. On the other hand Törnebohm and many others including Kühl chiefly on the ground of chemical researches consider Alite to consist of a system of lime, silicic acid and alumina, in which the molecular ratio between silicic acid and alumina on the one hand and lime on the other approaches the quotient 1:3. Kühl considers alumina-free tricalcium silicate as one limiting composition of Alite, whereas ordinarily some calcium aluminate displaces the silicate and gives to Alite its optically positive character, tricalcium silicate being negative. The view that Alite is an isomorphous mixture of tricalcium silicate and Jaeneckite is emphasized. The composition of Alite according to this view may be expressed as:

$$\text{Alite} = X\ 3\ CaO\ .\ SiO_2 + y\ 8CaO\ .\ 2\ SiO_2\ .\ Al_2O_3.$$

H. Kühl (Zement, November 17, 1927).

GYPSUM INVESTIGATIONS DURING 1927 BY THE BUREAU OF STANDARDS

GYPSUM had considerable attention by the Bureau of Standards during 1927. The work of importance and a summary is presented below with the approval of the Director of the Bureau of Standards.

Expansion of Calcined Gypsum on Setting

The expansion which occurs when calcined gypsum sets is one of its important properties. This property makes gypsum an excellent material for casting purposes as it enables the material to give true reproductions of the mold. In some other uses this expansion is undesirable and is to be avoided if possible.

An investigation was conducted to determine whether it would be possible by simple methods to control this expansion. It was found that the expansion might be controlled within certain limits by control of the ingredients of plasters and of the conditions under which they are used.

An increase in the proportion of mixing water decreased the expansion. Using a given proportion of water, finely ground gypsum expanded much more than coarsely ground gypsum. With sand as an aggregate, an increase in the proportion of sand decreased the expansion, while a mix made with coarse sand expanded less than one with fine sand, when the amounts of sand used were the same.

Retardation of the setting time had little effect on the final expansion but caused an initial contraction so that the final volume was less than that obtained with unretarded materials. Evaporation increased this effect.

Variations in the time and temperature of calcination were tried but these produced little differences in the expansion on setting. The use of certain admixtures decreased the expansion to a marked extent.

Gypsum-Sanded Plasters

In an investigation dealing with plasters of different formulas information has been obtained relative to the effect of certain materials on some of the more important physical properties of gypsum-sanded plasters containing these materials. Sand, hydrated lime, talc, asbestos, and two types of clay were the materials studied. These were added to both 1:2 and 1:3 gypsum-sanded mixes in quantities sufficient to replace 5, 15, and 25 per cent of the calcined gypsum present. Each mix so prepared was tested for workability, tensile and compressive strength, water-carrying capacity, time of set, and wet volume. The effects of varying the amount and grade of sand were also studied. A new method of determining the degree of workability of gypsum-sanded plasters by means of a modified Emley Plasticimeter was developed.

It was found that for straight sand-gypsum mixes the workability and strength of the plaster decreased as the sand-gypsum ratio was increased. Within certain limits the strength of a gypsum-sanded plaster decreased and the workability increased as the fineness of the sand was increased. In most cases the addition of the various admixtures resulted in an increase in ease of workability and a decrease in strength of the plaster.

An Acoustical Gypsum Plaster

A plaster which will absorb 10 to 15 per cent of the sound striking it will remedy the conditions of most of the auditoriums, theaters, churches, etc., having acoustical defects. An investigation has been conducted during the year having as its object the development of such a plaster.

To absorb any appreciable amount of sound energy a plaster must possess a porous surface of such a nature that the sound will penetrate into the plaster and be changed to some other form of energy. The surfaces of the ordinary sanded plasters or of the lime-gypsum white finish coat does not have the required porosity, hence practically all sound striking such a plaster is reflected back into the room. This condition gives rise to the objectionable echoes and reservations which are so often found in public buildings.

By adding small amounts of alum and aluminum sulphate and a carbonate ($CaCO_3$, for example) to a calcined gypsum-sand dry mix it has been found that a plaster may be prepared which possesses the desired characteristics of surface porosity and which may be easily worked and applied. When this plaster is wetted the alum and carbonate react to form carbon dioxide (CO_2) which is entrapped in the body of the plaster in the form of countless minute bubbles of gas. When the plaster is applied to a water absorptive backing such as an ordinary scratch or brown coat of plaster the excess water in the wet acoustical plaster is partially removed by the absorptive effect of the backing and the water films surrounding the gas bubbles are broken, leaving a large number of communicating small pores throughout the plaster. These small gas bubbles also serve another purpose in increasing the workability of the plaster and thus making it easier to apply.

Many different types of aggregate have been experimented with in an effort to find the most satisfactory one for use. Among those investigated may be mentioned sand, pumice, raw and calcined diatomaceous earth, cinders, ground cork, asbestos, tufa stone (a volcanic ash) and several others. Of

these the pumice, calcined diatomaceous earth, and tufa stone produced the most satisfactory plasters. A plaster containing two parts granulated tufa (graded to pass a No. 14 and be retained on a No. 40 sieve), one part sand (graded from sieve No. 10 to sieve No. 30) and one part of calcined gypsum, to which was added a small amount of a calcium carbonate-potassium alum mixture and a retarded, had approximately the sound absorbing properties desired. It is possible to increase the percentage sound absorption by increasing the tufa-calcined gypsum ratio, increasing the tufa-sand ratio, or increasing the particle size of the aggregate.

Deterioration of Calcined Gypsum

The common method of storing calcined gypsum is in paper or cloth sacks, neither of which is air tight. It has been found that calcined gypsum in certain cases, when stored for long periods in this manner, deteriorates. This deterioration is evidenced by poorer working qualities. The deterioration is by no means universal, gypsums produced in certain sections being practically free from deterioration while with those from other sections the deterioration constitutes a serious difficulty.

While there is little evidence as to the cause of the deterioration, it is commonly supposed to be due to partial rehydration of the calcined plaster, caused by absorption of moisture from the air. From the varying rates at which this rehydration occurs, it would seem to be, at least in part, due to certain catalytic agents present in the form of impurities in the gypsum. This view is supported by some data on the effect of storage of gypsum, developed at the Bureau of Standards for use in another investigation. In the course of this investigation several samples of calcined gypsum, representative of the industry throughout the country, were exposed to the air for six months. At the end of this period moisture determinations showed that rehydration had occurred, and to a greater extent in certain samples than in others.

An investigation has been started to determine the causes of the deterioration and also to determine methods by which it may be prevented. The first step in this investigation is exploratory in nature, being, namely, to check the assumption that the rehydration is catalysed by certain impurities. A good grade of calcined gypsum was obtained, and approximately 70 portions of this gypsum were intimately mixed with one per cent of various impurities. These portions with several blanks of the original gypsum were analyzed for moisture content and then exposed in shallow trays. After several months' exposure the moisture content will be again determined.

Limestone Research

The results of the determination of certain of the physical properties of the principal limestones of the United States ordinarily employed for cut stone construction have been published as Bureau of Standards Technologic Paper No. 349. This paper contains the results of tests on 134 samples of limestone from Alabama, Illinois, Indiana, Kansas, Kentucky, Minnesota, Missouri, New York and Texas. In addition to the usual physical determinations of strength, elasticity, absorption and porosity, this publication contains results of weathering, discoloration, fatigue, permeability, thermal expansion and efflorescence tests. The average strength in compression perpendicular to the bedding was indicated to be 9030 pounds per square inch with a range from 2500 to 28,400. A comparison of the results of various tests in this series has indicated the following average ratios for limestone:

Tensile strength : Compressive strength = 0.05
Transverse strength : Compressive strength = 0.17
Shearing strength : Compressive strength = 0.20
Compressive strength wet : Compressive strength dry = 0.91
E in flexure : E in compression = 0.75
Absorption (2 weeks immersion) : Porosity = 0.70

The use of elastic pointing materials in masonry construction has assumed such importance that a study of the merits of such materials has been deemed advisable. An investigation along this line has been started in connection with the co-operative work being carried out by this Bureau and the Indiana Limestone Co. The main points under consideration in this connection are as follows: 1. The ability of the preparations to maintain a waterproof joint when submitted to strains similar to those caused by structural movements. 2. Effects of high and low temperatures equivalent to the usual annual temperature range. 3. Discoloration or other undesirable effects caused by the use of such materials on stone masonry.

Weathering Tests on Building Stones

Freezing tests are in progress on samples of natural building stone from a considerable number of important deposits in this country, to determine the relative resistance to frost action. Due to the length of time required to make such tests it has not been possible to publish a complete report on this work. The results of frost action tests on limestone so far as completed were included in Technologic Paper No. 349. Improvements have been made in the automatic freezing and thawing apparatus which will add materially to the facility of this work.

Reads Every Word

Earle C. Williams, Superintendent, River Rock Plant of the Associated Gravel Company, Tracy, California, comments on Pit and Quarry as follows: "You are turning out a good magazine and I read every word of it. Your articles on 'Crushers and Their Component Parts' are especially interesting."

EFFECTIVE QUARRYING OF GARNET FOUND IN WHITE MOUNTAINS

By F. A. Westbrook

IN THE heart of the southern part of the White Mountains, at an elevation of 1800 feet above sealevel, is the garnet mine of the Wausau Abrasives Company in North Wilmot, New Hampshire. The location of the quarry commands a panoramic view of the surrounding mountains, covered almost entirely with spruce, white pine and hardwood forests with only here and there a cleared field and pasture where some hardy farmer somehow manages to wrest his living out of the rocky land. Just how any one happened to discover just that one small spot in all the vast expanse of mountain and forest where a rich commercial possibility was located, must remain something of a mystery. The fact remains that it was discovered and that in 1909 J. F. Davenport of Boston organized the United Mineral Company, built the plant and operated the property until 1920, when it was taken over by the Wausau Abrasives Company of Wausau, Wisconsin. Mr. N. Davenport, son of the founder is vice president and superintendent at the mine.

The finished product of the New Hampshire plant is garnet ground to various degrees of fineness which is shipped in bags to a large number of manufacturers of abrasive products as well as other manufacturers who use it for a variety of grinding operations. Of course a large proportion of the output is taken by the company's Wausau plant and a considerable tonnage is also shipped to England and Germany every year. In fact the field of possible usefulness for this comparatively new abrasive seems to be very wide and it is enjoying a steady growth.

Quarry Car and Tracks to Top of Crusher House

Garnet of sufficient richness for commercial purposes and in a sufficient quantity for large scale working occurs in very few localities in the world. In fact at the present time there is only one other plant producing important quantities of this material and this is at North Creek, N. Y., in the Adirondack Mountains. There are several small operations but their total output is very small.

The manner in which the ore is taken out of the ground, crushed, sent down to the plant and ground

View of Quarry

Cableway and Bucket at Left Terminating Over Ore Line

is interesting and well planned from an engineering standpoint. The quarry itself is not very large, being about 25 feet deep and covering not over an acre. Of course, it must be borne in mind that producing garnet abrasive is not to be compared to the production of crushed stone. Garnet is a valuable, highly refined product not in any way bulky. The garnet bearing ore occurs in a sort of lens and there is one dike of rock passing through it which must be removed and is waste. Otherwise the proportion of barren rock constituting waste is very small. Garnet crystals occur in quartz, feldspar and mica with a percentage varying from forty to seventy-five. The crystals are not of a sufficient degree of perfection to be suitable for semi-precious stones.

One of the Screens

On account of the texture of the ore being broken up by the garnet crystals it is of rather a friable character. It is drilled by an Ingersoll Rand jack hammer and blasted with 60 per cent Du Pont gelatine dynamite. Where large pieces of rock are broken loose they are shattered either by redrilling and blasting or by setting off a mud blast. On the whole, the more the ore is broken up the better. It is placed in Easton end dump cars by hand, and pushed along tracks in the quarry to the foot of the incline. At the bottom of the inclined track from the surface there is a turn table so that cars may be run to or from the workings in the quarry.

Cars are hauled up the incline by means of a small home-made hoist equipped with a 7 h.p. General Electric squirrel cage motor. From the top of the incline the cars run by gravity to the crusher house on the side of the mountain. Waste material is run out on a trestle from which it is dumped. Rails and various other mill and quarry

View of Quarry Floor, Showing Ore Ready for Loading in Cars

A General View of the Plant

supplies are purchased from the John B. Varick Company, Manchester, N. H. There is also a blacksmith shop at the top of the quarry where drills are sharpened and ordinary repairs made. The forge here is equipped with a Canady Otto Manufacturing Company Royal Western Chief forge blower. Compressed air for drilling is supplied by an 8 by 8 Ingersoll Rand compressor located in a building of its own and driven by a General Electric motor.

Dump cars loaded with ore from the quarry enter the top of the building on the side of the mountain, as already stated. They are dumped into a small Sturtevant jaw crusher and from this the ore drops into a bin. This building is located 300 feet above the plant and about 1200 feet away from it. A double cableway, furnished and installed by the Leschen Wire Rope Company, extends from one to the other. Three-quarter yard buckets are used, the loaded bucket hauling up the empty, thus eliminating the necessity of mechanical power. Supplies are also brought up to the quarry in the empty bucket. As Mr. Davenport says, "The buckets make a round trip in two minutes comfortably, which is a thousand per cent more efficient than trucking could be." As a matter of fact it is easily conceivable that this is under-estimating the efficiency of the cableway. The whole business of getting out ore and transporting it down to the plant is done by twelve or thirteen men.

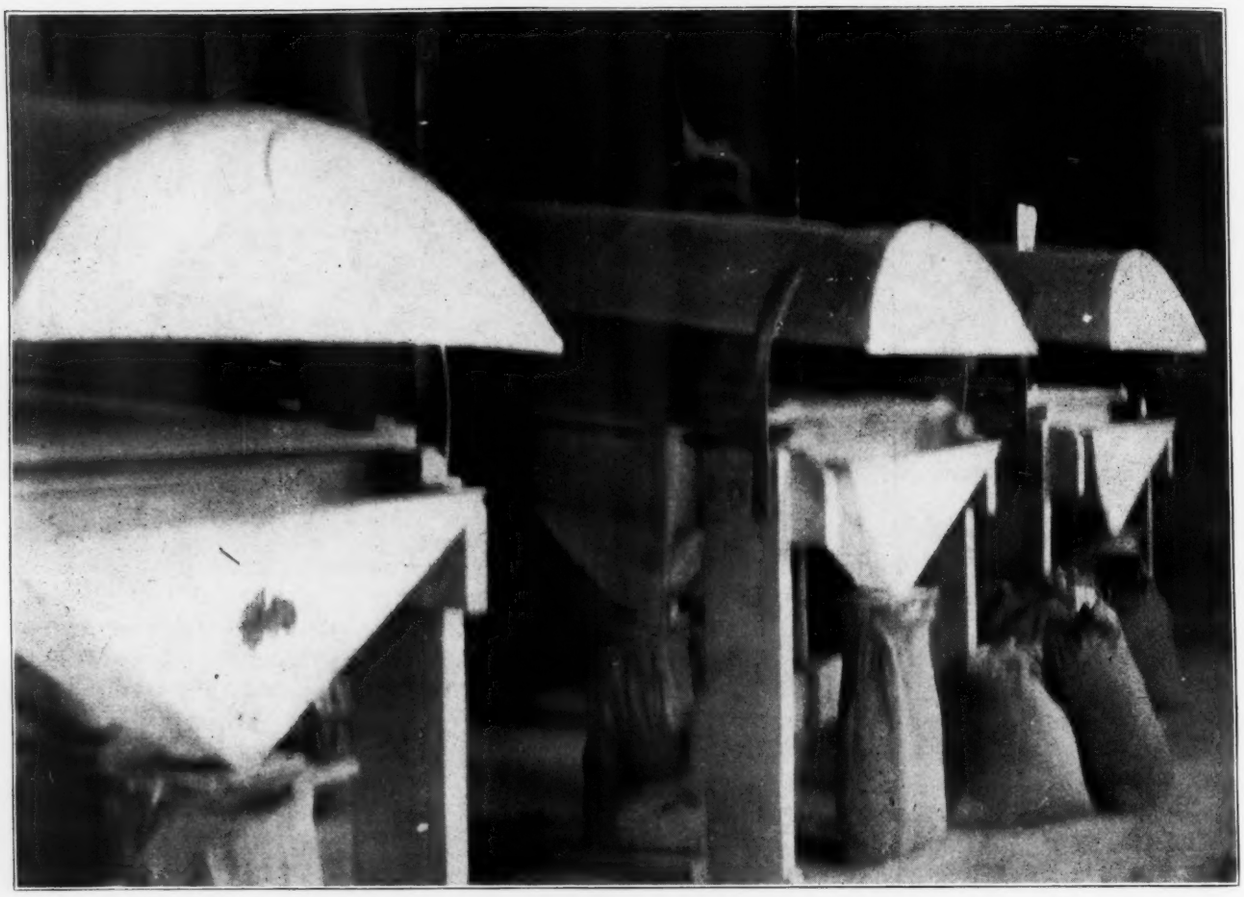
The speed of the buckets, obtained from the Leschen Wire Rope Company, is controlled by a brake, the bands of which are a Johns-Manville product. One man attends to loading the buckets from gates at the bottom of the bin and also controls the brake.

When the loaded bucket arrives at the plant it is automatically dumped into the ore bin. When the latter is filled it overflows through openings on to the ground. It is customary during the summer and autumn to build up a surplus of ore at the plant to last through the winter so as to avoid the necessity of operating the quarry during the season of heavy snow and intense cold. The bin is filled from the stock pile by means of an elevator.

Refining the ore, that is getting rid of the rock in which the garnet is imbedded, is a simple process to follow although a good deal of machinery is required. That mechanical handling has been cleverly devised is shown by the fact that three men can handle a production of 10 to 15 tons a day.

Ore from the storage bin passes through a wood chute to a 15 inch by 26 inch Sturtevant roll crusher. A home-made elevator, all elevators are home-made, then takes the material to an American Process Co. rotary dryer. Wood or coal is burned in this. From this it is taken by an elevator to a 4-mesh Newago screen. If the ore is dry it is bypassed around the dryer by means of a screw conveyor from the top of the elevator from the roll crusher direct to the Newago screen. In some cases the ore may be in such condition that only a portion of it should go direct to the screen and the re-

Bagging Concentrated Garnet



Part of the Grinding Tables

mainder through the dryer. This is easily managed by a gate at the end of the elevator. Just what proportion needs drying is determined by experience. This is a matter of technique which is important because by it considerable savings in power and fuel become possible.

The oversizes from the screen pass through a chute to another 15 by 26 inch Sturtevant roll crusher and then back to it by the elevator from the dryer. This is called the crushing department and all the machinery in it is driven by a 50 h.p. General Electric squirrel cage motor. Dust from the elevators, screw conveyor, and the bin for the troughs under the Newago screen is exhausted and blown into the outside air by means of a Greene Fuel Economizer blower.

From the latter bin the material drops to a 6-mesh Newago screen and the troughs from this to a double deck Newago screen having 10- and 22-mesh screens. Troughs from the latter pass over two home-made reciprocating screens having 36- and 48-mesh openings. Six sizes are thus produced which go to separate bins.

Pipes extend from each of these bins to the concentrating tables, of which there are two. Sometimes each size from the tables is kept separate and frequently they are mixed, depending on market conditions. One table takes the two larger sizes and the other the next three smaller sizes. The smaller is concentrated, or refined, in the grading plant.

The concentrating, or separation of garnet from the rock in which it was imbedded, is done on Sutton, Steele and Steele, Inc., dry concentrating tables. These have a quick reciprocating motion with a short stroke and thus, due to the difference in specific gravity of the good and waste materials, separate them. On this account reasonably careful preliminary grading by the screens already described as to size is necessary. The refined garnet drops from the sorting tables into boxes. Pipes extend from the latter to the bagging station where the concentrated garnet is weighed out in 100 pound bags, on a Fairbanks scale, and stored for further use. Each concentrating table is provided with a dust collecting system having a Greene Fuel Economizer blower. This keeps the garnet clean as well as the atmosphere of the room.

The grading plant consists of four home-made reciprocating grading screens and a Sturtevant laboratory roll grinder. Garnet from the bags in the store house is dumped into a small elevator which carries it up to a hopper feeding the grinder. After grinding it is raised in an elevator to a bin over the first of the four grading screens. Whenever it is required to run the material through more than the first screen it is carried to the next one called for by hand in a bag. Each screen has

a small elevator leading to a bin over it and the bag is simply emptied into the proper elevator. This gives a flexibility in grading which would not be possible with mechanical handling between screens and as the amount of material which must be taken from one to another is not great this is not a serious matter. In order to keep the graded garnet clean and to secure good working conditions in the plant a dust collecting system with a Buffalo blower has been installed which takes the dust from each grader.

In the grading room there is also a home-made concentrating table for a final recleaning of graded material before shipment. All of the garnet is not treated in this way, especially that sent to the Company's Wausau plant for further processing. However all material shipped direct to customers is treated in this way. It includes passing it over a magnetic pulley made by Mr. Davenport from three cast iron wheels with the sections of the rim between spokes removed and coils wound on the latter.

Power is supplied by the Company's own power plant. This consists of an Erie City Iron Works boiler (Economic Type), of 125 h.p. capacity, an American Ball engine and a General Electric Company three phase, 2300 volt generator. All of the electric equipment, with one exception noted below, in the plant is General Electric. In addition to this there is a 30 h.p. Chicago Pneumatic semi-Diesel type oil engine in which kerosene is the fuel used. Shafting has been placed so that it can also drive the grading screens and laboratory roll grinder, as well as a small Eddy Manufacturing Company direct current generator for lighting. The purpose of this is to enable this part of the plant to be run when the main power plant is shut down, as is sometimes economical in winter.

From the foregoing description it is not hard to see that this plant is well equipped and organized and to the visitor the well kept and clean condition of all departments is additional evidence of good management.

Shovel Developments

The Orton Crane and Shovel Company recently has brought out three new models of cranes, all of which are convertible into shovels, draglines, ditchers and skimmers by changing the booms.

The Model "A" crane has a capacity of 6 tons, and can handle a ½ yard bucket with a 30 foot boom; as a shovel it has a capacity of ½ yard. This model is exceptionally economical for small excavating jobs.

The Model "G" is rated at 10 tons, or 1 yard, and is adapted for excavating and contract work. It has sufficient capacity for serving a 27E paver, and, like the Model "A," can be shipped without dismantling.

The Model "W" is rated at 12 tons, or 1¼ yards, and is adapted for jobs where a large amount of material must be handled quickly and economically.

Ratings are conservative because all working parts are made with a liberal factor of safety.

Freight Car Loading

	1927	1926	1925
January 1	740,348	741,560	767,398
January 8	940,800	867,622	934,170
January 15	950,045	897,735	734,022
January 22	950,969	925,696	897,368
January 29	950,369	925,696	897,368
February 5	970,892	914,491	920,130
February 12	968,317	917,625	903,935
February 19	960,373	932,281	933,888
February 26	923,849	912,935	964,096
March 5	994,931	964,939	932,044
March 12	1,005,715	967,425	926,119
March 19	1,006,861	977,018	911,481
March 26	1,008,888	967,945	932,769
April 2	992,745	928,303	932,400
April 9	959,474	929,343	918,400
April 16	956,875	964,794	923,844
April 23	955,215	973,158	961,186
April 30	1,026,440	995,408	984,073
May 7	1,024,416	996,216	983,034
May 14	1,029,126	1,029,748	985,879
May 21	1,016,803	1,039,070	978,306
May 28	1,026,397	1,080,786	913,087
June 4	911,298	944,864	998,243
June 11	1,028,305	1,052,451	989,873
June 18	1,016,351	1,036,643	984,583
June 25	1,018,206	1,055,362	993,173
July 2	1,021,262	1,065,641	866,099
July 9	839,308	897,556	986,893
July 16	1,016,782	1,076,372	1,012,854
July 23	1,012,424	1,078,193	1,033,519
July 30	1,045,621	1,095,997	1,045,626
August 6	1,024,218	1,075,392	1,052,518
August 13	1,049,280	1,102,660	1,064,476
August 20	1,066,636	1,081,503	1,079,995
August 27	1,109,225	1,128,563	1,124,438
September 3	1,117,069	1,143,448	1,102,785
September 10	989,472	1,024,998	975,499
September 17	1,127,613	1,182,641	1,112,009
September 24	1,125,868	1,175,407	1,121,025
October 1	1,126,390	1,180,049	1,113,283
October 8	1,100,552	1,074,928	1,106,036
October 15	1,119,872	1,202,780	1,106,009
October 22	1,128,486	1,200,941	1,120,677
October 29	1,112,621	1,208,878	1,091,154
November 5	1,038,852	1,112,621	1,062,646
November 12	974,862	1,106,889	1,049,940
November 19	968,103	1,071,707	1,057,923
November 26	840,803	937,844	923,206
December 3	915,408	1,051,219	1,020,839
December 10	877,600	992,855	1,008,696
December 17	868,162	944,396	969,738

VALUE OF SAFETY WORK

By Fred M. Wilcox
Chairman, Industrial Commission of Wisconsin*

BACK in 1911, the Industrial Commission was organized and at that time we passed the workmen's compensation act in Wisconsin. The organization of the commission grew out of the adoption of that law. Wisconsin was the first state to have a valid law in effect in the United States and with the coming of the workmen's compensation there was far greater interest in safety for our employees. We did not know in the days of common law how many accidents were occurring in the State of Wisconsin. If a man was very seriously hurt and it got into the newspaper, the heads of institutions read about it when they got home at night, but aside from that many of them did not know that their men were suffering injuries and death.

With the coming of compensation we had to pay for accidents. Our eyes opened and we began thinking of what we could do to avoid accidents. We were not concerned whether a man was going to prove negligent on us. We had a different situation, for compensation is a scheme by which we charge industry with all accidents occurring in the plant.

In the earlier days, when a man moved a table and his leg and the table leg be broken, the industry repaired the table leg but permitted the man to care for himself. The only way he could claim or collect indemnity was to establish negligence of his employer.

Accidents Charged to Industry

We are to the point now where we recognize that all accidents are a charge to industry and covered by the cost of the product. With the coming of the Industrial Commission and the enactment of the compensation act we added this on, because prior to 1911 we were trying to reckon with safety as a thing that you could govern by statute.

They figured that the legislature could write in the law all the things to be guarded, and tell you whether gears should be enclosed and the belt protected and that statute run the gauntlet of 130 members of the legislature, each sparring for advantages, but with the coming of 1911 we said this —Every employer in the state shall furnish his employee with a reasonably safe place to work, safe appliances, safe process and safeguards as they may be used to advantage. The legislature laid down that common principle, wiped out all the laws relating to what individual thing should be done and set up this standard of safety as a guide for employers. The commission pointed out the danger spots and dangerous processes and made such rules, regulations, and orders, general or specific, as necessary to the public to bring about a safer condition.

Writing the Code

I have never visited many quarries or mines but I have been in more factories, and I do not know very much about the hazards of quarries, mines or factories except as I read and I did not have much to do with writing the safety code except to O. K. it. I knew a lot of men in the state of Wisconsin who could write safety codes. I knew the quarry men and when we wanted a quarry code we picked out the men who were familiar with quarries and asked them to write their code. You said what you believed as employers and we put laboring men on with that committee and permitted them to suggest what the employer should do to satisfy them, and out of that committee comes a report saying on the part of the employers that they were willing to do certain things, and the laboring men said, if industry accepts those responsibilities we will be satisfied and we took this code without dotting an I or crossing a T and adopted it.

Some of the codes are highly technical. Just think of turning the electrical code over to a legislature of 133 men with the proposition of writing a code as technical as the electrical code of this state. It cannot be done, it is not modern, it is not practical and it is not the place to put it. The better way to do it is to pick out the men who know the hazards and let them write it, adopt it and go out and obey it.

We may guard our plants to the best of our ability and in compliance with every order in effect in the state and we will not eliminate all accidents. Mechanical guards will prevent a certain percentage of accidents and insure against them but it will not stop them all. You still have the hazard of man. You must contend with the carelessness of men who are willing to take a chance. And you should not be discouraged because you have accidents at times.

Accidents Will Occur

A year or so ago I was at a meeting and sat with Mr. Eisenacht of the Kimberly Clark Company who told me the Kimberly plant with 950 employees had gone 149 days without a lost time accident; the Niagara Wisconsin plant, 650 employees, 172 days without a lost time accident; the Niagara Falls, N. Y. plant, 550 employees, 208 days without a lost time accident, and the Canadian plant with 308 employees, 160 days without a lost time accident.

*Abstracted from address before the Wisconsin Aggregate Association, December 8, 1927.

There was a contest among 192 paper mills for the best safety record and Wisconsin won seven of ten first places in that contest. Just a few weeks ago, at the Kimberly plant, nine men had their lives crushed out and 25 or 30 were seriously injured because of the collapse of a building. We ought not to be discouraged because we have employees who will not recognize safety. You must stay everlastingly after them until you finally make them understand that a safe man is the only man that is safe for you, safe for his family, and safe for the public.

Experiences of 1926

Let me give you the experiences just tabulated for 1926 with 22,177 accidents which caused disability of over two thousand. Of that number, 213 were fatal; two were permanent total disability; 1,948 were permanent partial disability like the loss of a hand, foot, finger or eye and 20,014 of them were of the temporary class occasioning disability of more than a week. The total benefits paid out in the year 1927 was $4,728,128. The total is over five million dollars going out in compensation benefits each year.

Does safety pay? If we get rid of those accidents will safety pay us? I need not argue, but that is not all there is to twenty thousand accidents, occurring in the state. You pay 65 per cent and the balance of the loss the injured man or his dependents must accept. We do not figure disability at full wage loss, but the fact remains that all of the time these men were laid up they were suffering distress and pain, and we have the loss of production.

Of these permanent partial disabilities, 114 were injuries to arms, 98 to hands, 112 to legs and 90 to feet—414 of them. Of these 414 injuries, 39 of them were a total loss and 59 of them were over 50 per cent impairment. There was thumbs and fingers loss of 51; there were 87 eyes, 24 with over 50 per cent of disability and 40 with under 50 per cent of disability.

Now, that accident experience just appalls us. You men do not have to face many of these things; you do not have a large number of accidents in your plant but if you were in my place and had to reckon with widows and children, fathers, mothers and relatives of the 213 men who were killed, it would get in on you and you would agree to do anything to prevent accidents.

Compensation a Safety Measure

The increased compensation benefits under our laws is a safety measure and when an accident occurs by reason of your negligence then you must take the liability and you will still be paying less than the wage loss because if is 15 per cent of 65 per cent, or about 10 per cent. You cannot unload that on your insurance carrier. It is enough to tell you we will not have that guard off. We will put one on and see to it and stick close to that provision of our law and award increased compensation against you. There are 532 increased compensation cases in the year 1926 of which 16 occurred because of unguarded belts; 10 exposed pulleys and 40 unguarded gears; 15 because of ladders not equipped with safety points; 10 a lack of hand rails, one of the hazards in your industry. You have men climbing up where some of the works are and you should see to it that they have the best hand rails so if they do make a misstep they have support. 118 on punch presses; 12 for the lack of goggles; 11 on rolls; 21 on excavations; 96 by circular saws and 58 on insufficient scaffolds. The total compensation paid by the insurance carrier is $315,479 and the increased $47,851.

Increased compensation is one of the things that causes more friction between the employers of the state and the Industrial Commission than in any other provision of the law. It costs $47,851 in 1926 out of over five millions.

It cost you that compensation and all of those accidents could have been avoided and saved that money if the guard laws had been obeyed.

Child Labor Discussed

There is another point we come in conflict with you and that is child labor. You do not know why it is that a boy 16 or 17 years of age that looks as strong as you are, ought not be permitted to work in your quarry. The legislature has said that no person under the age of 18 shall work in any mine or quarry and we will not issue permits to any child to work for you, even though it is carrying water because he will be down in the quarry and when the accident occurs, then the treble indemnity has to be assessed against you. When we criticize you, when we find you with children in your employ, remember this: It gets us nothing except the satisfaction that we are enforcing the laws; but it is saving you from liability. You should be glad that we called your attention to it and see to it that it does not happen again.

Quarry Hazards

You have some outstanding hazards in your industry and I do not know very much about them, but this matter of caving down of the over-burden every little while kills somebody. Another serious matter in your work is handling explosives and operations where explosives are used. You do not have proper shelter or the men are careless, and that is one of the reasons why children ought never to be allowed around where you are handling explosives. You have so many people going back and looking into the hole when the thing is still sizzling and that should be guarded against and men should be cautioned to permit a sufficient lapse of time before going back to the blast.

You should be careful in the freezing and thawing seasons that you do not have accidents because

rock starts to slide on to your men. Ruptures caused by lifting are always a problem to you and many cases of hernia are chargeable to industry but some industries are more likely to have this burden than others and yours is one of them. You always have this hazard of dumping materials on toes and crushing fingers and it is everlastingly being added. Your gears must be completely closed. Your conveyor backs should be guarded where the nip is. Do not let your men put on the belt dressing as the belt goes into the nip, but on the other side as it goes away. See that your stairways and platforms are rugged and well protected. When you buy new machinery or build new plants see that your contractor agrees to do it in compliance with the code and when you buy new furniture see that it is guarded.

First Aid a Necessity

We are very much interested in this matter of first aid. The orders require that in every quarry you shall have at least two men who are well instructed to apply first aid. We reckon with the mining car for giving instruction to at least two thousand quarry men and highway workers and that is a fine piece of work, all within the last five years. This department at Washington is very anxious to come to Wisconsin because they are finding a better attitude on the part of the employers and that is commendable. They are to be in the state this winter and we expect they will run their car into at least nine different cities and give a course and we are anxious that you should at least correspond and co-operate with them to the fullest extent. You have many accidents—all industry does, in which men have to be resuscitated. You have to know how to do all kinds of first aid work and you should have men around the plant who know how to do it.

After all the foreman is the man that has the contact with the men doing the work and he is the man that has the contact with the man who gets injured. He should therefore be on the job in seeing to it that they adopt safe practices. Your offices, your superintendents and presidents and secretaries and general managers are away from the quarry where the hazards are and the right contact is not made so you must make certain that this fellow who is in the plant and has charge of these men actually knows his responsibility.

Just as I conclude I want to refer again to the fact that we are having nearly 25 thousand accidents that cause disability of more than a week each year, over 200 of them on the average are fatal and four or five hundred more are serious injuries and it is costing money and the amount that you pay in premiums and compensation cost is not nearly all of the cost. We should therefore reckon always that there is real value in safety work.

Power Show Best Ever

The Sixth National Exposition of Power and Mechanical Engineering far outstripped preceding events. During the week of December 5th, the Grand Central Palace received over 110,000 visitors at the exhibits of 530 manufacturers, arranged on four floors. 25,000 engineers and industrial executives registered their attendance. The products of the exhibitors were listed under 1,000 different heads. There were 450 exhibits dealing with the generation of heat and power and their distribution and utilization; 100 showings of instruments for recording and controlling temperature; and 100 showings of machine-shop equipment.

The stoker manufacturers had an exhibit of the latest types of equipment for burning fuel. Means for increasing the area of air-inlet, for admission of air above the coal entrance and for improving the methods of replacement of individual parts were shown. Pulverized fuel was represented at the Exposition with devices for adopting the principle of water-cooling to the walls of the combustion chambers. The problem of operating steam power stations with high pressures has been a problem in power plant design. There were several showings of boiler drums, headers and piping, valves and auxiliary equipment for operating at pressures up to 1400 pounds per square inch. Automatic combustion control was studied with much interest.

Several types of fans were shown which offer considerable advantages and which increase overall efficiency, and are so designed that adjustments may be made in the field to eight different positions. Heaters for raising the temperature of the air before entering the furnace were exhibited, and manufacturers of measuring instruments demonstrated that these instruments are finding new uses. Improved designs of carbon monoxide indicators and a temperature indicator for Diesel Engines, an integrator for a steam-flow meter, a precision barometer and new designs of draft gages were among the exhibitions. One exhibitor showed a new hydrogen welding process. Designs of refractories for air and water cooling and special arrangement for quick replacement and repairing secured the attention of manufacturers. Exhibits of ball-bearing manufacturers and all types of bearings and different kinds of belting made up the section devoted to transmission equipment.

Information Hard to Obtain Elsewhere

S. F. Spencer, of the Dresden Sand Company, Dresden, Ohio, writes: "We consider Pit and Quarry one of the best magazines published along our line. We look forward to receiving Pit and Quarry and certainly enjoy it. It has information which is hard to obtain from any other source."

DEHYDRATING SYSTEM APPLIED EFFECTIVELY BY HIGHLAND SAND AND GRAVEL

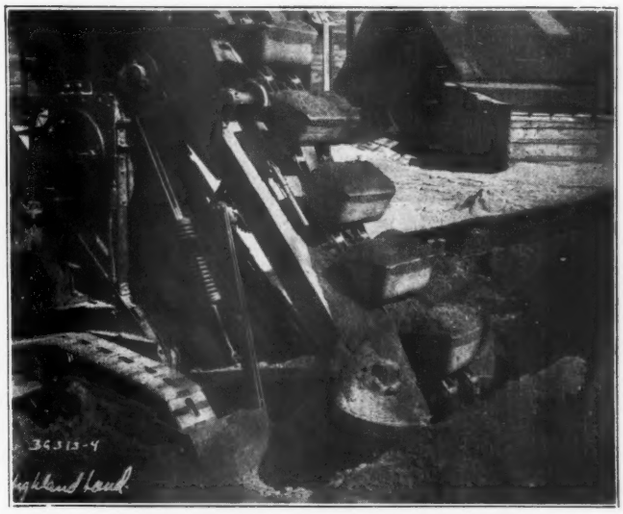
By Jack Turner

HANDLING their sand with much greater speed than the average sand and gravel yard —and at the same time employing the comparatively new "Dehydrating System" the Highland Sand and Gravel Company at Boston finds itself delivering enormous tonnages daily.

Using this "Dehydrating System" requires very little additional equipment—and is apparently the coming thing, as architects around Boston and vicinity now have the custom of specifying within very close limits the amount of moisture that shall be in sand delivered on the job.

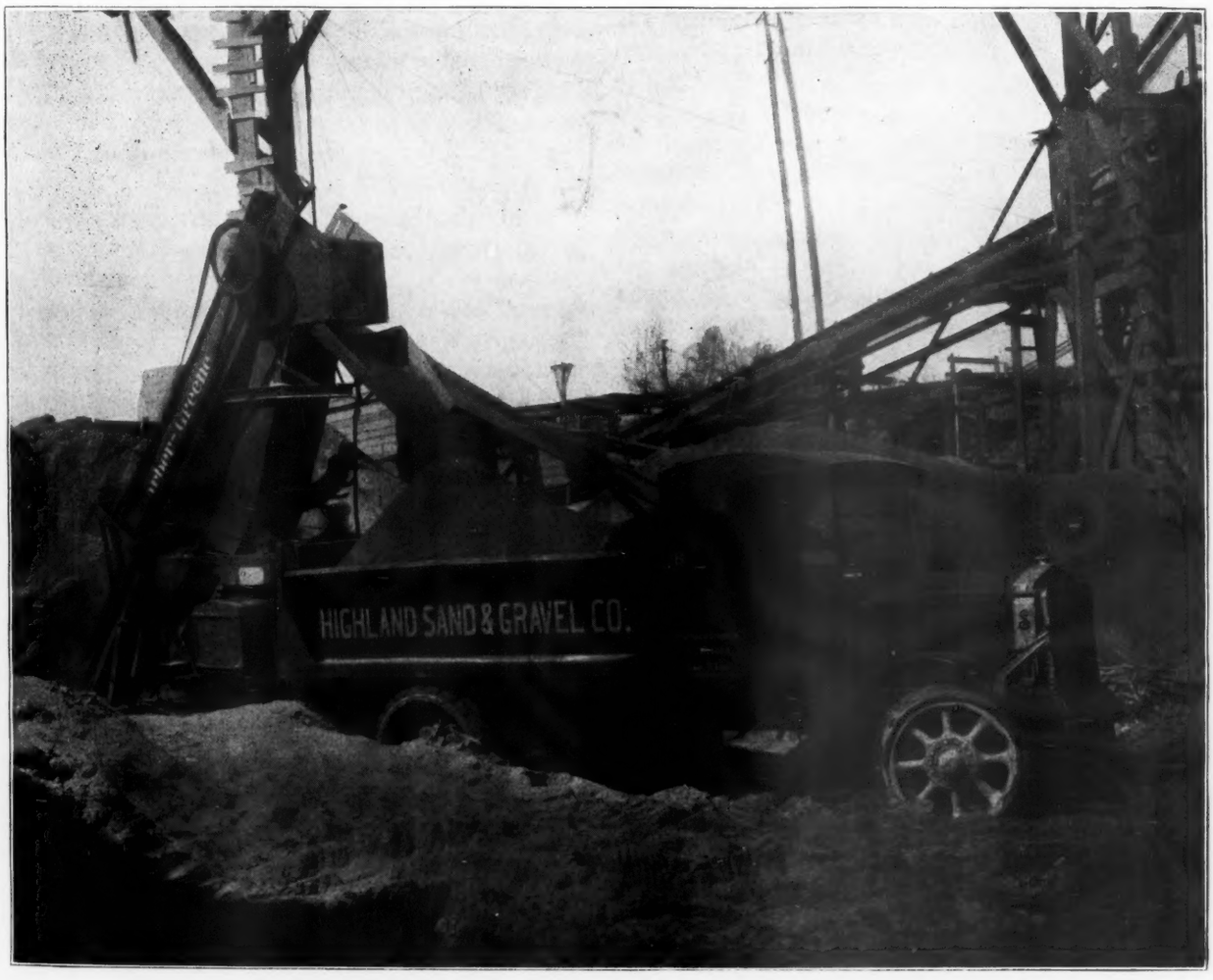
Regulating this moisture content can very easily be taken care of in a similar manner to the method used by Highland Sand and Gravel—and undoubtedly the day is coming when competition will force all sand dealers to "Dehydrate" in order to be in the "running."

This "Dehydrating" plan may be very simply described as follows:



Close-up View of Loader Digging

When the sand comes out of the scrub boxes—it contains from 25 to 30 per cent moisture. If this



Loading From Storage to Trucks

sand were immediately delivered on a concrete or plaster job, the contractor would never know how much water to add to his mix, as of course some of the sand would dry out on the way over and every load would have a different moisture content.

In order to avoid this, the method used by the Highland Sand and Gravel Company is to discharge one day's run on one pile and the next day's run into another pile, from a high permanent belt conveyor. In the course of several hours (two hours for a good average), this moisture content drops to between 7 and 8 per cent; or, in other words, the surface water runs out of the sand.

At the end of twelve hours this moisture content drops from 3 to 4 per cent. This amount at the end of twelve hours is between 3 and 4 per cent. This gives a steady moisture factor on which the contractor can base his mix, and as we mentioned above it is becoming the custom for architects around Boston to specify within very close limits the amount of moisture that shall be in the sand as delivered on the job.

In order to reclaim the sand from one pile one day and from another pile the next day, the Highland Sand and Gravel Company is equipped with a 42-A Barber-Greene bucket loader with which they do all of their reclaiming. This one machine which feeds itself by a patented disc arrangement at the lower end of the boom has reclaimed and loaded into trucks as much as 600 tons in a single day. The loader was put into operation during the early part of 1926—from March of that year to the end of the year, the machine loaded 104,000 tons of sand and 5,000 tons of gravel. The total amount of aggregate handled by the machine this year (1927) up to the end of November was 92,400 tons of sand and 8,000 tons of gravel. In spite of these enormous figures this Barber Greene has not been working all the time. During 1926 it averaged 400 tons of material daily and during the months of 1927 it averaged 350 tons per day. Variation in these averages was due to business conditions only.

Not wishing to be unfair in estimating the life of this type of machinery in years it was thought best to get in touch with Mr. West of the Highland Sand and Gravel Company who stated that he conservatively estimated that the machine was good for handling just as much more material as it has already handled on just as economical a basis.

A Separator Development

The increasing demand for finer products in great amounts to equal the capacities of the mammoth compartment mills now being manufactured, particularly for the cement industry, has necessitated the construction of air separators of a size heretofore undreamed of.

It must be realized that the use of Air Separators in closed circuit with the tube type of pulverizers (or in fact any grinder) has greatly increased the output of the latter, because it has allowed a much greater circulating load to be put through these machines, with a corresponding lower percentage of finished product in their discharges, but in aggregate a far larger tonnage. In other words, where formerly a compartment mill discharged a finished product, 85 per cent of which was 200 mesh and finer, now, by the use of an air separator in the system, the mill is required to discharge only 60 per cent of its output to that fineness, thus the material is passing through the mill at much greater speed, the air separator removing that which is finished, and returning the oversize to the mill with the fresh feed. The result is that instead of a pulverizer capacity of 80 barrels per hour, it is increased to over 100 barrels per hour, or as is often the case, the fineness is increased to over 80 per cent passing 200 mesh. In fact, the fineness and capacity is only limited to the ability of the mill to produce, as the air selector can remove dust of any practical fineness, and the Separator and not the Mill is responsible for the quality of output.

It is realized that 100 barrels per hour means 20 tons to be removed by air to a fineness of 85 to 92 per cent 200 mesh, a result that has only been possible very recently.

The Sturtevant Mill Company, who have just put on the market a 16 foot whirlwind centrifugal selector, capable of handling a circulating load of 400 bbls. (80 tons) per hour and delivering a product from as coarse as 60 mesh or as fine as 350 mesh, covering all present day requirements of the largest Mills so far manufactured.

While this Selector is built on the same general principles as the smaller Separators, so successfully used, yet it incorporates many refinements and necessities for these huge demands. Its construction must be such as to hold many tons of cement in its enormous cones, should a stopage occur; its feed opening must be of sufficient size to easily take an almost unlimited capacity, its setting cone must be big enough to collect and steep enough to discharge completely; its valves or vanes must be free and unhampered by the building up of cement which otherwise closes these openings and affects the fineness of its output. Its lubrication must be simple yet ample, and economical. The great fan must be balanced and vibrationless, and the power low, by the use of anti-friction bearings throughout, and lastly the machine must be scientifically designed, constructed and accessible. All these features have been studied and incorporated in the new Sturtevant.

To those unacquainted with this type of Selector, it may be well to say that it is a slow speed, low powered mechanism which contemplates little wear. There is no piping, no exhaust fan and no auxiliaries, it is complete in itself; two cones, one within the other; one big, balanced, slow speed fan; a distributing plate, and non-moving valves.

PROBLEMS OF MINERAL AGGREGATE PRODUCERS

By Stanton Walker
Director, Engineering and Research, N. S. G. A.*

THE Mineral Aggregate Industry has a multiplicity of problems which give a great deal of annoyance but nevertheless they may be of some benefit because in their solution we help a condition and develop the industry. They are annoying, beneficial and prevent stagnation. These problems may in a general way, so far as the producer is concerned be listed under two classifications, those of production and those of sales. I shall not venture to discuss any of the problems which appeal specifically to production or sales methods but shall confine my remarks to some of the general problems of the industry which may be said to be of more or less of a national scope and vitally important to both production and sales.

The established producer as a manufacturing operator has a considerable amount of invested capital. It is his problem to furnish materials to meet requirements for different purposes. It is necessary that he create a steady market for his product and he must maintain it in competition with producers and manufacturers of other materials which compete with concrete and he is also in competition with other producers of similar materials for the same purpose. He also has the competition for the casual, locally available material.

From my notes here I have a phrase which I was told to take as my own but I haven't the heart to do it. Mr. Shaw suggested a catch phrase for me to work on and that is that "concrete is no better than its aggregate." It may be a little worse, but no better. That is not surprising when you consider that seventy to eighty per cent of the concrete is made up of aggregate. That places a heavy responsibility on producers who furnish materials suitable for the use which they are to be put. It is primarily the producer's duty to furnish satisfactory materials and in order to do that the producer must have a thorough knowledge of what constitutes suitable materials. He must know the field of concrete. I propose to confine most of my remarks to the field of concrete since I think that is the individual field where most of us are vitally interested.

Development on Increase

Developments in the field of concrete have been very many and very rapid in the past 25 years. They have come so rapidly that many of us have had difficulty in keeping up with them. We have a great deal to learn yet however and there is a great amount to be done in distributing information which we have. While there has been a great deal learned about concrete I think that what we do know about concrete we ought to pass on to the consumers and I want to make two or three very brief and general statements. Some of us are inclined to place the responsibility for requirements on the consumer. Now we know the aggregate must be clean and free from harmful impurities. We know that great economies may be effected by using a well graded aggregate and that we must have uniform aggregates. Further than that we do not have a great deal of accurate information concerning concrete and aggregates. Questions as to durability as to the amount of impurities being present I will discuss a little later, but we still have a great deal to learn. As I said before some of us perhaps feel inclined perhaps to place the responsibility for the statement of what constitutes proper concrete on the consumer because he is buying the stuff and using it, but let me tell you, you tell him to tell you what he wants and we will furnish it if we can. I don't think the responsibility can be entirely placed on that one side. The gravel, sand, crushed stone and mineral aggregate producers cannot avoid accepting some of the responsibility for that and it is to his advantage to accept that responsibility and to help educate the consumer to the use of proper materials.

Since my paper has as its subject a discussion of the problems of the mineral aggregate producer, I think that one of the first things to do is that of educating the consumer to the fact that mineral aggregates are manufactured products. Many people think that sand and gravel is something dug out of the ground and that crushed stone is quarried. They don't realize these processes are purely preliminary steps in obtaining the raw material and that it must be put through the manufactured process to obtain clean and screened materials to fit the requirements of the work in which it is to be used.

Water Ratio Theory

I think perhaps that a brief review of the fundamental principles of concrete mixtures might be in order at this time. I shall not take the time to go into details for things developed by research partly because of lack of time and partly because that is embraced in the statement of some of the recent developments. I refer particularly to the development of the water ratio theory, that method or proportion of water with the concrete based on the kind of mixed water. As you all know the quality of concrete is fixed by the quality of mixed water. If a given quantity of mixing water is used with a

*Presented before the Wisconsin Mineral Aggregate Association, December 8, 1927.

given quantity of cement, then the strength of the concrete is fixed in certain limits by that ratio. So long as they are free and clean from harmful impurities and make concrete of the proper kind of strength without much refuse and weight, they are graded. We must also take into consideration the question of uniformity of aggregates. Now often we can take any kind of mixed water and aggregate and get a satisfactory strength but we can get a much more satisfactory concrete with well graded aggregate because we can make a leaner mix. For simple comparison where the bank run mixture is being used with the same materials thoroughly separated and proportioned it would show a difference of something like 1.50 per cubic yard of concrete for the same strength.

So I think in considering the so-called scientific methods of proportioning concrete based on the water rush we will effect the greatest economy by using properly prepared materials.

It is unnecessary to discuss very much the necessity of using clean materials. We all know that sand and gravel coming out of a bank may or may not contain impurities organic in nature which will entirely destroy the hydraulic property of the cement. I think the first essential of an aggregate is its cleanness and its durability.

Well, our more recent information concerning the laws which govern the proportioning of concrete are fairly well known among progressive engineers but we must not overlook the fact that we have only touched the field of digging, users of concrete, aggregates and fundamentals and the real significance of these laws. Many benefits may already be observed from the development and knowledge of aggregates but there is still a great deal to be done.

I shall not go any further into the details of the theory of concrete mixtures, perhaps discussion which will follow this talk may bring out some points.

Properly Prepared Specifications

Another large problem encountered by mineral aggregate producers are those arising from unintelligently or improperly prepared specifications and from improper and unintelligent inspection methods. In overcoming problems of this sort it is very necessary that the producer be thoroughly familiar with his materials and the laws that govern him in the manufacture of concrete. Too many specifications are transplanted from one locality to another and not written with local conditions in mind. I am thinking of a case in a state some distance away from here where one of the best concrete sands produced in the state is being rejected for highway work because of specifications which were not written with the sort of material available in that state in mind. It was more or less a transplanted specification. That may have worked wonderfully in another state but it didn't work there and it would accept, in main, worse sands than this which it would reject. As to the details of your specification requirements no more than 15 per cent shall be retained on a number 10 mesh sieve. If there is more it is not a workable concrete. Now this producer had good coarse sand but it did not come up to that particular specification.

Properly Considered Specifications

Another example of inconvenience to the producer which comes about from improperly considered specifications. A certain producer was on the border line of two states. The engineers in the two states had different ideas of what constitutes proper concrete sands. Consequently there was a general mixup with a great deal of trouble to the producer to try to fulfill both specifications. There are numerous examples of this sort. In a city where producers supply materials to foreign states and counties surrounding this city matters of this kind may come up. Every man has different specifications and working methods and different ways of testing materials. In consequence it keeps the producer in hot water constantly. It would seem if the material is proper for one group of engineers it should be proper for another or improper. We run against the same difficulty in many cities due to the different ideas of different architects of what constitutes proper materials. You may have in one state a half a dozen different ideas and you are probably familiar with the difficulties which occur with them but nevertheless a great many annoying things arise due to unintelligent and inadequate specifications. I have in mind a case in one state in which the producer of sand was having rejections by the inspector on the job. He would send samples to the State Highway Department to be tested and they would accept it and the report would go back and then a different office would use the sand and in the meantime a lot of demurrage would pile up on the car costing a lot of money. This producer tested every carload of sand shipped for the purpose of knowing whether it was all right and to cut down the rejections. When we came to look into the real trouble we found out that the field inspector was making the tests wrong but still making them in accordance with the outlines laid out for him by the materials engineer at headquarters.

These troubles however became localized more or less. I recall a case where a gravel producer had had his grade accepted for six miles of road and used and all of a sudden they shut down on him for no apparent reason. I think that particular job required that the gravel be 100 per cent crushed and accepted it that way for six miles and then in came a new inspector on the job and he wanted 2 per cent of uncrushed gravel in there and said he couldn't use it. That was overcome by getting some of the more responsible people on the job and

using a little horse sense in the matter but that is an illustration of some of the things we have to combat and which we can combat most readily by knowing something about the effects of these various factors.

One or two other things occurred to me, one of sand in one of the western states which was being sold in a territory which had always been served by an established producer. That sand didn't meet the specifications of the engineers in charge of the work and there was a lot of see-sawing back and forth before the matter was finally adjusted and of course there was a lot of delay which involved expense on all sides.

Standardizing Sizes

There are a lot of problems of general interest to the industry as a whole, the solution of which will help to solve these small difficulties. I think one of the biggest problems which any individual producer will not question is the adoption of some sort of system of standardized sizes, standardized specifications and standardized testing methods. You know the situation with reference to standardized sizes, you may have a dozen producers in the same town, one will produce maximum grade for reinforcing at 1¼ inch—another at 1 inch and so on down the line. I think a great deal can be done for the industry in working out some means by which we can cut down the number of different sizes of material which are furnished and thereby add immensely to the economy of production. I want to discuss that a little more thoroughly at another point.

The question of standardizing specifications is not quite so simple. We cannot write one specification which will be applicable over the entire country. It must be written with local conditions in mind. On the other hand there is no doubt in my mind but we can formulate a definite form of specification that will not take in the characteristics of different localities but will take in the different limits in different localities.

All of this points toward the fact that while we know a lot about our materials there is still a whole lot more to learn. Now as to what is being done in the matter of standardization a number of organizations are working on it as you know. There is being a definite and concerted effort made to establish a standardized system of sizes. That work was initiated largely by one of the Major Committees of the American Society of Testing Materials and they are making recommendations of the sizes of materials which shall be standardized. In that work the aggregate associations have been invited to cooperate. In our co-operation with them we established a committee on standardized sizes and have made certain tentative recommendations to this parent organization of the A. S. T. M. as to what we consider proper sizes to standardize. That committee is made up of 12 to 13 members and I think there was one from every section of the country and we tried to arrange our limits in such a way that we wouldn't tread on everybody's toes and it would be of general benefit to all. So far as grading is concerned work is being carried on by the same organization. The A. S. T. M. has already adopted certain specifications for testing grading. Some criticisms have been made of their weight limits but they had to be wide because of the widely different conditions throughout the country. I think the trend in specification writing—I am not going into that subject by the way—in the A. S. T. M. and the A. C. I. is to limit—or rather eliminate the different limitations and recommend a form of specification and perhaps make recommendations as to variations in limits permitted but not as to what the limits should be.

Information Available

I think it would be opportune here to discuss something of the work of the two aggregate associations. I will give you a brief outline of what the National Sand and Gravel Association is doing, things that you should know. They are working on co-operating with specification bodies in the preparation of specifications, uniform specifications as outlined above, distributing information which will show the desirability and economy obtained from using prepared materials. Our work is along the same lines as the A. S. T. M. Our activities are divided into two general classifications, those handled by Executive Secretary Mr. Ahearn which involves matters which come under the scope of a secretary, income tax problems, car shortage problems, freight rate problems and information of that sort. The Engineering and Research Division covers a multiplicity of fields. I might say most of our time is spent on three general lines. That of preparing literature which we hope will be helpful in the promotion of the industry; that of providing engineering service either by personal contact or correspondence with members of the association and with engineers and consumers of the product and that of cooperation with the specification bodies. We consider that one of the most important features of our work. I look at it a little bit in this way. In Wisconsin you elect various representatives and Senators who go to Washington and make laws of the country. There are a great many law-making bodies who are doing work which vitally affects the mineral aggregate industry and it is necessary that the mineral aggregate industry have representation on these law making bodies and a very considerable amount of the time which we spend is in committee work for the purpose of protecting the aggregate industry.

We feel that the distribution of literature which gives information concerning the sand and gravel industry is highly important. Possibly the stuff

you read may not appeal to you as being interesting or startling or spectacular but it is one more drop of water added to the whole thing and it is helpful.

The Engineering and Research Division of the Association is slightly less than two years old. During that time we have prepared three formal bulletins and two circulars have furnished numerous articles to the National Sand and Gravel Bulletin. The first bulletin we got out was last year on the importance of uniform aggregates and control of concrete mixtures. In that publication we cited economies affected and the difficulty of using materials not uniformly graded. That should be of some assistance in promoting the idea of using properly prepared materials and we feel it may of of some assistance for the average producers to realize the importance of this proposition and to educate his clients to the same idea. He could do this by distributing bulletins or talking about it to them. Our second bulletin which we call our Bulletin 1 because we started it out on different lines is on estimating materials for concrete. It is accurate and has come to be an accepted method of the kinds of material used in concrete and undoubtedly brings out the advantages of using properly prepared materials for that purpose.

The third bulletin is on the relation of aggregates to concrete and we felt this was a means of getting before the consumer of sand and gravel and crushed stone the importance of using cleanly prepared materials.

The Association hopes to extend this work to a considerable extent in the near future. We hope to establish a research laboratory early next year. I think the benefits derived from such a laboratory will be great. I believe the benefits derived from an association whose entire time will be devoted solely to the problems of the sand and gravel industry cannot be overestimated. There are, as I have previously stated, a great many unsolved problems in the industry as you know—and there are a great number of researches being made. We get a great deal of valuable information from these researches and undoubtedly as long as our specific problems are not being considered erroneously, conclusions are arrived at which help us but they do not go far enough sometimes and we feel we would like to get into this game ourselves. It is entirely proper also that the aggregate industry should bear its fair share of the cost to develop information concerning its own material. The National Crushed Stone Association is taking a similar step and undoubtedly the work in their laboratory will follow along very much the same lines as our own and as we are in close touch with each other we hope we won't duplicate one another's work. Mr. Goldbeck and myself are in close touch with each other for that reason.

Supercements

The proper grinding and mixing of the raw materials and the correct burning and grinding of the clinker are important as well as the chemical composition. Too fine grinding of the clinker may result in flash set, or in too bulky a cement or may increase laitance. It is suggested that the fact of the low tensile strength relative to the compression strength may be taken as an indication of concealed unsoundness in present day high-lime supercements. The early strength of certain cements is obtained by increasing both the silica and the lime with the addition of some fluorspar to control the burning temperature. In Kühl cement iron and aluminum are high, while silica and lime are a little low. In other cements calcium chloride seems to play an important role. The best procedure for the future consists in searching for catalysts or promoters, but the lack of scientific knowledge of the hydration and hardening processes hinders the search. H. Kühl (Tonindustrie Ytg. 51, 1927, and Chemical Abstracts. Nov. 20, 1927).

Gasoline Tax Receipts

Motorists paid the governments of 44 states and the District of Columbia approximately $101,251,000 in taxes on gasoline purchased by them from January 1 to June 30, according to reports received by the U. S. Public Roads Bureau. This total represents an increase of 19.2 per cent over the gas collections for the corresponding period of 1926.

Taxes on gasoline were collected during the period in all states except Massachusetts, New York, Illinois and New Jersey. The last two named states have since put gas taxes into effect.

The total tax indicates a consumption of gasoline amounting to 4,919,000,000 gallons for the entire United States during the first six months of 1927. This consumption includes estimates for the four states in which no tax was levied. It indicates that automobiles this year are consuming gasoline at a rate of 11.4 per cent in excess of last year.

All but a small portion of the gas tax yield was expended to build and improve highways.

California collected $9,036,000 in gas taxes during the first half of 1927, or more than any other state. Ohio ranks second with collections totaling $7,540,000, Pennsylvania third $6,102,000, Texas fourth $5,976,000 and Florida fifth $5,355,000.

The Weber Engine Company, manufacturers of the "Weber" Semi-Diesel Oil Engine, announces that its line of Oil Engines will now be available for what may be termed Industrial markets, in addition to the Oil Field Industry, in which industry the "Weber" Engine has been sold almost exclusively.

BUREAU OF STANDARDS INVESTIGATIONS ON LIME DURING 1927

DURING 1927, several interesting studies concerning lime were conducted by or in cooperation with the Bureau of Standards. For the convenience of our readers this work is summarized below with the approval of the Director of the Bureau of Standards.

Composition of Chemical Lime

In connection with the preparation of specifications for lime for the chemical industries complete analyses have been made of thirty-five representative samples of chemical quicklime and hydrated lime from widely separated parts of the country.

Briefly, the results show the SiO_2 content of the limes to be from 0.11 per cent to 4.01 per cent. Of the thirty-five samples analyzed, thirty contain less than 1.00 per cent SiO_2. With the exception of one sample, which contains 0.92 per cent, the Fe_2O_3 content of the entire group is below 0.35 per cent. The Al_2O_3 content varied from amounts "not detectable" to 2.75 per cent. Manganese was found to be quite low, the highest percentage determined being 0.10 per cent, yet most of the samples had this constituent present in "traces." (Less than 0.01 per cent). Arsenic was not detected in any of the limes by the Gutzheit method, using ten gram samples. The calcium oxide content was uniformly high, varying within quite narrow limits for respective high calcium and dolomitic limes. The average CaO content of the high calcium limes approximated 96 per cent. MgO was present in two samples in dolomitic proportion, otherwise it varied from 0.11 per cent to 3.88 per cent. The SO_3 content varied quite widely from traces in a number of samples to 4.33 per cent. This constituent was not detected in two samples. CO_2 was present in the samples in amounts varying from 0.02 per cent to 4.72 per cent. P_2O_5, although present in only small amounts, was not an uncommon constituent, the amounts varying from "not detectable" to 0.20 per cent. "Loss on ignition" averaged approximately 1.00 per cent for the quicklimes and approximately 25 per cent for the hydrates. One sample showed 2.77 per cent of "insoluble matter" in 1:9 HCl while the remainder contained less than .70 per cent.

Fineness of Slaked Chemical Quicklime

A determination of the "fineness" of slaked chemical quicklimes has been made during the year. Many of the chemical industries using lime find it advantageous to use quicklime in order to utilize the heat of hydration. This principle is used, for example, in the liberation of NH_3 from the ammonical liquors produced in the by-product coke industry. In those industries in which quicklime is used as a reagent, it is desirable that during the process of hydration the disintegration of the quicklime should be as complete as possible. A fine state of subdivision increases the rate of solution and the speed of reaction. Coarse material not only decreases the rate of solution and efficiency of the lime but also has a deleterious effect on processing machinery. In following substantially the practice recommended by the American Society for Testing Materials for determining the fineness of masons' hydrated lime, the following results were obtained:

Sample No.	Retained on No. 30 Sieve %	Passing No. 30 sieve retained on No. 50 sieve %	Passing No. 50 sieve retained on No. 100 sieve %	Passing No. 100 sieve retained on No. 200 sieve %	Passing No. 200 sieve %
11	0.9	0.8	2.6	0.9	94.8
21	2.2	1.7	0.7	2.2	93.2
24	3.1	2.3	1.3	3.7	89.6
28	10.3	2.2	2.1	2.2	83.2
35	3.1	7.4	6.9	5.6	77.0
17	2.6	2.5	3.6	3.8	87.5
8	1.6	0.7	1.6	1.3	94.8
38	22.5	3.1	3.1	2.0	69.3
19	4.8	3.7	2.0	2.9	86.6

Manufacture of Lime

Changes occurring in the lime industry since the issue of Technologic Paper No. 16, "The Manufacture of Lime," in 1913, made necessary a revision of this publication. To obtain the information desired, twelve lime plants, one ready-mixed mortar plant and one limestone crushing plant were recently visited. Many innovations in the lime industry were observed. The data collected were used in the revision of the technologic paper and included information upon the following: 1. The production of chemical lime; 2. the latest type of gas fired kilns; 3. new processes of hydration; 4. burning of lime in rotary kilns; 5. automatic stokers as applied to shaft kilns; 6. the mining of limestone.

Furthermore, the inquiry was conducted with a view of obtaining complete information about the process of lime manufacture; of noting the methods of quarrying or mining and crushing; of selecting representative samples of limestone which were forwarded to the laboratory for analysis and study; of observing the methods of burning, temperature and duration of burning, and of sampling the resulting lime; and of following this through the process of hydration and of sampling the resulting product.

Some Properties of Quicklime Mortars

The putty yield of different quicklimes, per unit of weight, varies with the chemical and physical properties of the quicklimes. This difference in putty yield has been the subject of considerable discussion in the preparation and use of quicklime mortars. Magnesian quicklimes with lower aver-

age putty yields than high calcium quicklimes will under certain conditions produce stronger mortars than those prepared from high-calcium limes and this has been the basis for the statement that mortars of magnesian limes leaner than those of high-calcium limes can be used with satisfactory results. A comparison of the putty yields of the quicklimes to the strength (tensile and compressive), plasticity and shrinkage of mortars prepared from them indicates that the greatest amount of sand that can be employed with a quicklime in the preparation of a mortar can not be determined by its putty yield.

Low Density Dynamites

For many years the density of dynamites was a fixed and unchanging quality. Gelatin dynamites ranged from 84 cartridges in the 1¼x8 inch size to the 50 pound case to 90 cartridges, depending upon the percentage strength, and from 33 to 40 cartridges in the 4 inch diameter. Straight and ammonia dynamites both had the same density, ranging from 102 to 106 cartridges, 1¼x8 inches, to the 50 pounds and from 12 to 13 cartridges in the 4 inch diameter. No one gave very much thought to the influence of the bulk of an explosive upon its action until permissible explosives came into competition with black blasting powder in coal mines. In the effort to secure a grade of lump coal with the permissibles which would be comparable with that mined with blasting powder it came to be realized that the distribution of the charge through a greater length of bore hole was an important factor in the action of the latter explosive and this led to the development of the low density ammonia permissibles. Duobel, manufactured by E. I. du Pont de Nemours and Company, Inc., and averaging 160 cartridges, 1¼x8 inches to the 50 pound case, was the first of these.

It was found that this explosive could often be charged cartridge for cartridge against permissibles which ran only 135 cartridges to the case and pull an equal burden with consequent saving in cost of explosives, and the idea naturally occurred that low density explosives might be economical for other kinds of work than coal mining. As a result Durox was developed by the du Pont Company, also running 160 cartridges in the 1¼x8 inch size to the 50 pound case. This explosive proved efficient and economical in mining salt, gypsum and limestone and in quarrying the softer types of stone, especially as a top load.

Consequently when the operators of open pit iron mines of the Mesaba Range decided to discontinue the use of black blasting powder because of the danger of ignition by sparks from steam shovels and sought a less inflammable powder to take its place, the explosive offered by the du Pont Company, and the one finally adopted, was a low strength, low density ammonia powder.

Thereafter the demand for bulky dynamites grew and most of the manufacturers put on the market one or more brands of this type. For a time 160 cartridges, 1¼x8 inches, seemed about the furthest limit to which bulk could not be increased without destroying the necessary sensitivity of the explosive. Before long, however, the du Pont Company discovered a new kind of pulp for an absorbent which led to the manufacture of Monobel number 10, a satisfactorily sensitive permissible averaging 185 cartridges to the case.

Continued study of the problem of increasing the bulk of ammonia explosives other than permissibles has resulted during the past year in the development of a series of eight low density powders which range in cartridge count from 115 cartridges in the 1¼x8 inch size to 172 cartridges, and in cartridge strength inversely from 20 to 55 per cent. These are marketed under the old brand name du Pont Extra and designated individually by the letters of the alphabet from A through H.

The three chief requirements that a low density powder must meet in order to be efficient are first, that it shall be satisfactorily sensitive; second, that it shall actually develop in use its theoretical stick strength, and third, that it shall not give off more obnoxious fumes than the higher density powder which it is intended to replace. These requirements du Pont Extras, which have now been in use about five months, seem to satisfy.

The great advantage of this type of explosive lies, of course, in the economy it permits. It has been found, in blasting clay, gypsum, shale and limestone in various localities, that one of the du Pont Extras could be substituted for Red Cross Extra or other standard ammonia explosives or one of the lower grade gelatins and loaded cartridge for cartridge with equally good results. It is not intended by any means to imply that a low density explosive will prove economical in these materials in every case. Its execution will depend upon the characteristics of the deposit and the working conditions and its desirability for any particular mine, pit or quarry can be determined only by trial. All that can be said is that results thus far secured with du Pont Extra in such relatively soft materials warrant a trial in similar materials, for where it does the work of a higher density explosive on a cartridge basis, it accomplishes a material saving.

Cement

The ground cement is graded according to grain size and these different sizes form various qualities of cement. Various mixtures of differing grain sizes may also be made. S. L. A. Oden (Swedish Patent 62, 701).

A SURVEY OF THE SURFACE TREATMENT FIELD

By C. N. Conner,
Chairman, Low Cost Improved Roads Investigation Research Board

LOOKING back a number of years we find high type pavements have met the needs of thickly populated communities. During this time many rural sections have not been as fortunate. In fact it was not until after 1920 that appreciable mileages of low cost improved roads began to appear. These untreated surfaces were not expected to carry heavy traffic. But with improved methods of maintenance, reconstruction, betterments and new construction highway engineers have rapidly extended road service to these rural sections. The results of their efforts have been effective but they have not kept pace with the ever mounting vehicle registration. Just what has been accomplished and how it was done is a subject which I have found intensely interesting during a two years' survey of low cost improved roads.

Pyke Johnson says there are 22,000,000 motor vehicles in use in the United States, 87 per cent passenger cars, 12.8 per cent trucks and 0.4 per cent busses. The task for the road builders is to give them highways to roll over. Our total road mileage is about 3,000,000 of which 85 per cent are unsurfaced, 10 per cent are a low type surfacing such as untreated sand clay, gravel and stone; 4 per cent are an intermediate type and less than 2 per cent are high type surfaces. These figures indicate that a high percentage of our roads will need some type of surfacing or surface treatment within the next few years, if the now isolated sections are to have service.

Curves of motor vehicle registration are still pointing upward toward the northeast corner of the chart. For example right now there are several states south of the Ohio river and west of the Mississippi which need a large mileage of low cost surfaces and surface treatments. At least one of these has less than 10 miles of high type surface and no surface treatments. The North and South Atlantic states and a few Middle Western states have used surface treatments for at least a decade. It is only recently, however, that states with large areas and comparatively small population have entered the surface treatment field.

There appears to be a tentative agreement among road builders that untreated sand clays and gravels have a limitation of from 300 to 800 vehicles per day without excessive maintenance costs. Some states do not believe in surface treatments. They do not think the cost is justified and that the next upward step from an untreated gravel or sand clay calls for a surface of the pavement type. Those who have inherited old macadams and stone roads are frequently willing to salvage them by adding a surface treatment. There is evidence, however, that not only macadam but also gravels and sand clays can be satisfactorily surface treated and that their traffic capacity may be doubled at very much less than half the cost of the pavement type.

About 1920, when automobile registration began rapidly to increase, it was found that funds and time were lacking to give road service over a sufficient mileage to satisfy the public. The construction of high type roads required more time, more money and more detours than many portions of the country could divert to road building. There were conditions where the present and probable future traffic did not warrant so great an expenditure. By some engineers it was considered more important to connect objectives and build feeder roads to trunk lines with a roadway capable of taking traffic up to 1,500 vehicles per day. And so this new era of low cost construction began. Today we find their ideas bearing fruit and an ever increasing interest in roads of this type.

There are two principal classes of surface treatments, bituminous and non-bituminous. Some non-bituminous surface treatments have been used successfully in certain localities. The degree of success varies considerably with climatic conditions. Here today we are principally concerned with bituminous materials. The bituminous treatments are adaptable to varying conditions of climate and aggregate. Besides laying dust and preventing loss of binder they have a definite salvage value from year to year.

It has been said that a bituminous surface treatment is at its best during the first year of service. This was probably true until quite recently but some maintenance engineers are finding ways and means to refute this argument. How they do it is an interesting subject beyond the scope of this paper. Until about 1920 asphalts and asphaltic road oils were used primarily as dust layers, thin surface treatments and as binder for penetration macadams. There were some exceptions such as the road oil work in Long Island and a fair mileage of the city type of bituminous pavements or rural highways. This was the beginning.

Just now, as a result of very little research, some experiments but with a large amount of usage we find three principal methods of bituminous surface treatment. They are: (1) The Skin Surface Treatment or Penetration Method, Hot or Cold. (2) The Mixed in Place Treatment, Cold. (3) The Pre-Mixed Method, Hot or Cold. Each of these principal methods has its advocates and is subject to variations in the classes of bitumen and aggregates used. A brief description of each will be given.

1. Skin Surface Treatment or Penetration Method

This method is generally used on well compacted dense bases which do not have a loose surface.

The bituminous materials are a cold bitumen for the first, or prime coat. Generally a cold tar, a cut-back asphalt or low viscosity road oil. The second application may be a second prime coat of the same bitumen. The seal coat is generally a heavier bitumen such as a hot asphalt, hot tar, a cold cut-back asphalt or a heavy road oil. The aggregates for cover material range all the way from a coarse clean sand to ¾ inch stone or slag. Cover material should be hard and durable.

Construction methods are simple and consist of: (1) Cleaning the base. (2) The application of a prime coat of low viscosity bitumen. (3) Ten hours to several days to allow penetration. (4) A second prime coat of the same bitumen may be advisable for the more porous bases. (5) A light cover may or may not be used on the prime coat. Better penetration results, when not used as the cover, takes up some of the bitumen. Traffic requirements may make the cover necessary. (6) and (7) The last application of the heavier bitumen and cover of sand, gravel, stone or slag. The so called inverted penetration method means that the bitumen is applied before the final cover. The inverted method is the more common practice. (8) The surface thus formed may or may not be rolled. Best practice calls for rolling with a light or heavy power roller. A heavy roller should not be used on a relatively soft aggregate. (9) Seal coats or a third application are sometimes used to seal the surface if open or to build up a greater thickness.

Maintenance methods include retreatments, patching, scarifying, reshaping and retreating of the original surface treatments.

The cost of the first year's treatment will be considered as the orginal cost. This will naturally vary with the cost and class of materials used. Asphalts generally cost less than tars. Cut back asphalts cost more than road oils. Sand for cover costs less than stone. Annual scarifying, reshaping and light retreatments may add to the maintenance cost. A smoother riding surface is obtained than when a large number of small patches are used. The skin surface treatment for the first year as here described will cost from about $1,000 to $2,500 per mile for an 18 foot width. The annual maintenance cost is subject to many variables of climate, materials, base, traffic, thoroughness and intelligence of maintenance. When serving within its traffic capacity the annual surface maintenance cost does not exceed $1,000 per year under unfavorable weather conditions. Under favorable weather conditions and on excellent bases the maintenance cost will not exceed $500.

The traffic capacity of this type under favorable conditions of base and climate is probably 2,000 vehicles per day, without excessive maintenance. Higher capacities have been reported. A fair average traffic capacity on gravels and top soils is from 800 to 1,500 automobiles and light trucks. A higher limit may be reached on lime rock or stone macadam bases. Examples of this type of surface may be found in use from Maine to Florida, in California and Oregon, and in portions of the Middle West.

II. The Mixed in Place Method, Cold

This is a method that is new, within three or four years. Its purpose is to consolidate the existing loose or unstable aggregates by mixing them on the road with bitumen. Surfaces containing such aggregates as crushed or screened gravel, stone and sand clay or sand loam have been thus improved.

Either asphalt or tar have been used as bitumen. In a few instances both have been used. They range all the way from fuel oils as used in California to cut back asphalts in North and South Carolina and tars in Wisconsin. The bitumen should be such that it will not become sticky or "set up" until sufficient time has elapsed for the necessary manipulation of the mixture. The road oils which do not contain a solvent set up more slowly than the cut back asphalts. They also leave a more plastic mixture. The surfaces which contain such aggregates as crushed or screened gravel and crushed stone have generally been selected for treatment. There is evidence, however, that poorer materials such as sand clay may be thus sufficiently stabilized and its traffic capacity increased.

Construction methods are briefly listed below and are subject to some variations in different parts of the country. (1) Smooth the existing surface. (2) Scarify if necessary, harrow, machine and shape. (3) Apply first coat of cold bitumen and mix with harrow and road machine blade. Sometimes harrowing is omitted. Blading is seldom omitted. (4) Apply second coat of bitumen and mix thoroughly. (5) Sometimes a third coat is applied followed by more mixing. (6) Mixing is continued until a uniform color results. (7) Following a final shaping with a road blade or a drag the surface preferably is rolled for final compaction with a power roller. Some engineers secure compaction by traffic. (9) A seal coat may be used if needed. An open surface may indicate this necessity or a lean base may be the indication.

These surfaces are built as thin as about 1 inch and as thick as 3 inches. Maintenance methods may include seal coats or patching with a mixture of aggregate and bitumen. If the orginal mixture was too lean, a remixing with more bitumen may be indicated; if too rich, a remixing with more aggregate may be the solution.

For an 18 foot width of treatment the cost will range from $1,100 or $1,200 per mile to $5,000 or $6,000. The class of bitumens used as well as the depth of treatment will affect the cost. Most of the surfacing has been on gravels and stone roads. The first cost for these has averaged less than $2,000 per mile.

Some of these surfaces are carrying a counted traffic of between 1,000 and 2,000 vehicles per day without signs of serious fatigue. The surfaces are smooth and comfortable to rise upon, much smoother than the average skin surface treatment or rolled hot top. The mixed-in-place surfaces may be built without serious interruption to traffic and the inconvenience of heating operations. This type of surfacing may be seen in service, but with some variations in construction methods in California, Wisconsin, Indiana, Tennessee and North and South Carolina. Although the sand oil roads in Long Island are a mixture of fine gravel, sand and loam with a slow curing oil the foregoing construction methods do not apply as closely to them. The construction and maintenance operations eventually build up a mixed in place surface after two or three years.

III. The Premixed Method, Hot or Cold

This class of surface treatment is in reality a thin surface course as we have been accustomed to consider surface or wearing courses, such as bituminous concrete and sheet asphalt. By laying them thinner than standard practice or by using local materials it is expected to secure a surface whose first cost is less than $12,000 or $15,000 per mile. Included in this classification are such hot mixes as sheet asphalt and bituminous concrete of the fine and coarse aggregate types. The laid cold surfaces are cold-patch bitumens, cut-back asphalts and road oils premixed with aggregate. Your association knows and engineers know that natural rock asphalts are a competing material within certain freight zones. They may also be classed as premixed cold surface.

For the hot mixtures standard specifications describe suitable bitumens and aggregates. The cold mixtures for surfacing are newer. Specifications for them are not as well standardized as a whole. Specifications for Amiosite and cold patch mixtures which may be used for surfacing are available, as are also those for Uvalde Rock Asphalt, Alabama Rock Asphalt and Kentucky Rock Asphalt. Some experimentation and a little usage indicate that there is a possibility of producing an "unnatural" or synthetic rock asphalt. That is, one which may have many of the characteristics of sand rock asphalt.

If the applied surface mixture is to be less than about 1½ inches in thickness and the base is porous or semi-porous then a primary coat of suitable cold asphalt or tar is recommended. A binder course of "black base" or a thin course of penetrated stone will add to the stability and assist in keying the top to the base. In one state, Michigan, both the prime coat and binder course are used on gravel base. The top course is a stone filled sheet asphalt or fine aggregate type. The construction of the top itself varies very little from standard methods as found in The Asphalt Association Specifications. They include proper dumping, spreading, raking, patching and rolling. Final compaction by rolling must be secured in less time for the hot mixes than for the cold.

This class of surface treatment is generally maintained by patching with the same material as in the surface or by cold patch mixes.

The aim in this class of surfacing is to secure a surface which will cost less than $1.00 per square yard, or about $10,000 per mile of 18 foot width. Rock asphalt has been laid in Texas for a ½ inch depth at $3,700 per mile, 1 inch for $5,400, including a prime coat of oil. In Michigan a prime coat of tar, a light binder course and a 2 inch "Topeka" top is costing around $13,000 per mile. Some work in Georgia using about 2 inches of penetrated stone and about ¾ sheet top cost approximately $12,000. When local materials may be used as aggregates the costs have been considerably reduced for the hot mixes. There is little cost or usage data available for hot or cold pre-mixed surfaces one inch and less in thickness. Here and there are isolated sections but Texas seems to have the largest mileage of thin premixed surface treatments.

The traffic capacity of those types on substantial bases has been estimated and counted as between 1,000 and 2,000 vehicles per day. Some are carrying more. This type of surfacing is not as smooth to ride over as the mixed in place surfaces. The cold mixes have some apparent advantages over the hot mixes. This advantage is apparent principally during the construction period. There is less interruption of traffic, less expensive equipment is required, and cost of plant operation is reduced.

Summary

As a summary of the surface treatment situation, based on observations of usage and a study of present practice and conditions, it appears, (1) that surface treatments should not be less than 18 or 20 feet in width and preferably from shoulder to shoulder. (2) That flat crowns of ⅜ to ½ inch to the foot are sufficient for drainage. Flat crowns add to the comfort and safety of automobile travel. (3) That a cold prime coat of bitumen should precede a bituminous surface treatment on a compacted base. (4) That a hot or cold treatment may be used as the final application. (5) That a surface treatment method which includes blading is smoother riding than one which is rolled only. (6) That cold surface treatments of the mixed-in-place and premixed methods offer a wide field for im-

mediate and future business. (7) That there is a need for standardization of names for surface treatments; and of specifications for materials, tests and methods of construction.

The surface treatment field is continually changing in character and territory. Its character is being changed by improved quality of workmanship and methods. The territory is growing to include larger areas and new fields. In the future we shall see a great number of highway departments employing engineers of training and experience as supervisors and foremen, a closer contact between laboratory and field surface treatment work, and a greater amount of surface treatment work let to contract.

46 States Tax Gasoline

Gasoline taxes now are paid by motorists in forty-six states and in the District of Columbia, and range from two to five cents per gallon, according to reports collected by the U. S. Bureau of Public Roads. Gasoline is untaxed in New York and Massachusetts.

During the first half of 1927 the tax was levied by 44 states and the District of Columbia. But New Jersey put a levy of two cents a gallon into effect July 1 and Illinois began collecting a like tax on August 1.

A tax of five cents is collected in four states. One state charges 4½ cents and seven charge four cents. In three states the levy is 3½ cents while in 15 states it is an even three cents and in seventeen it is two cents. The average levy is 2.55 cents per gallon.

California receives the largest revenue from the gas tax, having collected over nine million dollars from motorists in the first six months of 1927. Ohio's yield was second followed in order by Pennsylvania, Texas and Florida.

Lumber Consumption

Approximately 33,331,000,000 feet of native lumber were consumed or utilized in construction in the United States in 1926, according to an estimate just completed by the U. S. Agriculture Department in cooperation with the U. S. Census. This includes 27,357,000,000 feet (b.m.) of softwoods and 5,974,000,000 feet of hardwoods. The consumption estimate does not include about 1,940,000,000 feet of lumber imported from foreign countries.

Per capita consumption, including imported lumber, amounted to 305 feet, the department reports, adding that this represents a decrease of about 15 feet from the average per capita consumption of the three preceding years.

The United States total cut of lumber during the year was reported as 36,930,000,000 feet, the difference between prduction and estimated consumption being accounted for by exports of 2,699,000,000 feet and the net increase in stocks on hand.

California consumed approximately 3,511,000,000 feet of lumber or more than any other state. New York ranks second with a consumption of 2,832,000,000 feet and Illinois third with 2,325,000,000 feet. In seven other states the consumption was more than 1,000,000,000 feet each.

F. W. Erlin, Vice President and General Manager, Coast Rock and Gravel Company, San Francisco, California, says

> "The fairly properous condition of the State generally and the prospect of a considerable increase in railroad and State Highway work here, which for the past year or so has been extremely light, would seem to indicate that our industry as a whole can look forward to 1928 with confidence for a fairly active year. The additional gas tax, which was voted in this State last year, will mean, we are informed, an expenditure of approximately $25,000,000 by the California State Highway Commission for maintenance and new construction work and this, together with the other factors mentioned, should go far towards assuring a reasonable tonnage at satisfactory prices to all producers."

Construction of Apartment Houses

The trend of residential construction in the United States during the last two years has been predominantly in the direction of apartment houses.

New quarters for 95,448 families were provided in apartment structures planned for erection during the first six months of 1927, according to a study of building permits in 80 cities which has just been completed by the United States Labor Department. New quarters provided for families in single dwellings which were projected in the same period totaled 57,899. Other residential construction, largely of the double house type, provided new quarters for 24,204 families.

In the first six months of 1926 the largest proportion of new family quarters was also reported as in apartment house construction. The reports show 100,201 new family quarters created in apartments, 71,818 in single dwellings and 26,727 in double houses. From 1922 to 1925 inclusive new construction provided a larger number of family quarters in single dwellings than in apartment houses.

Information procured through the Pit and Quarry Magazine has been of much value, and a great deal of machinery has been purchased from the companies that advertise in the Pit and Quarry.

BLUE TALC PRODUCED ON RED MOUNTAIN BY NATIONAL TALC LIMITED

LOCATED on Red Mountain, British Columbia, approximately twenty-three miles from Banff, Alberta, is the property of the National Talc Limited. The vein is of massive formation, with a deposit 200 feet in width and 3000 feet long, located 7,850 feet above sea level. A road is being

Sawing a Block of Blue Talc

Blue Talc Vein 3000 Feet Long, 200 Feet Wide and 600 Feet Deep

constructed 16 miles up the Red Earth Valley, connecting the operation directly to the Canadian Pacific Railway, at Massive, reducing the route to shipping point by seven miles.

The unique feature of this ore is its color, which is blue, caused by the impregnation of amorpheous graphite. There are several additional varieties and grades of talc in this deposit, consisting of blue and white solid blue, white and greenish white and many other color combinations. The solid blue talc has been tested and found suitable for lava purposes. It works easily and burns to a pure white at a temperature of 2700 degrees Fahr., and is so hard that it will cut glass. Negotiations are under way with an American company for the purchase of the blue talc.

The company has an additional deposit of white cosmetic talc on Mount Whymper, British Columbia, close to the Banff-Windermere Highway. Chemical tests have proved that this talc nearly meets the theoretical requirements of the composition of pure talc. It is sea-green in original color, but grinds to a pure white. The company is well financed and is developing the property as rapidly as weather conditions will permit.

The officers of the company are as follows: Major-General Sir Henry Mills Pellatt, C. V. O., president, William Henry Matthews, vice president and managing director, and E. T. Bartlett, secretary-treasurer.

Bank Deposits Increase

Financial activity of the United States, as indicated by banking conditions, seems not to follow closely the fluctuations of general business. Bank deposits and bank loans show increases that occurred regularly in the last five years, it is revealed by an examination of reports received from all banks in the United States by the Comptroller of the Currency.

From 1923 to the present year, the aggregate deposits of all banks in the United States increased 26.9 per cent. Deposits each year were larger than in the preceding one. Loans, in the same period increased 22.9 per cent.

General business in the same 5-year period experienced two so-called "peaks" of activity with intermediate "lows." The years, 1923 and 1926, are remembered by most business men as "good" years. By comparison, general business activity was "low" in 1924 and in 1925.

In 1923 the aggregate of deposits of all banks was $40,653,000,000 on June 30. On the same date this year the aggregate was $51,612,000,000. The growth occurred steadily without a break.

Bank loans increased from $30,189,000,000 in 1923 to $37,131,000,000 in 1927. In this side of the bank ledger also the growth was regular, each year exceeding the year before it.

Many National Authorities Present at Recent Asphalt Conference

Most of the addresses and papers presented were of a highly technical character and will be found published elsewhere in these columns from time to time, in more or less detail. Among those who addressed the conference during its four day sessions were John R. Phillips of the Georgia State Highway Board; C. E. Jones, Chairman of the South Carolina State Highway Commission; Col. Woolsey Finnell, Director of Highways for Alabama; Ben M. Sawyer, Chief State Highway Commissioner for South Carolina; C. N. Bass, State Highway Commissioner for Tennessee; Dr. C. H. Straham, Dean of Engineering at the University of Georgia; Col. H. Keith Compton, Director of Public Works, Richmond, Va.; Charles L. Woolley of the Rhode Island Highway Department; A. R. Ebberts, Engineer of Tests, Alleghany County, Pa.; B. E. Cray of the West Virginia State Highway Department; A. W. Doe, New York; R. D. Kneale, Atlanta, Georgia; H. D. Howe, Rochester, New York; F. P. Smith, New York City; Roy M. Green, Lincoln, Nebraska; A. H. Blanchard, Toledo, Ohio; Julius Adler, Philadelphia, Pa.; Gene Abson of the Chicago Paving Laboratory; Warren H. Booker, Charlotte, N. C.; E. N. Seymour of the Georgia State Highway Department; Prevost Hubbard and F. C. Field, Chemical Engineer and Chemist, respectively, of The Asphalt Association, New York City; W. S. Hawkins, Gulfport, Miss.; Clarence A. Proctor of Detroit; G. F. Fisk, Buffalo, N. Y.; W. P. Cottingham of Gary, Ind.; V. L. Ostrander, Eastern Branch manager of the Asphalt Association of Albany, N. Y. and J. F. Bullen, Shreveport, La.

The arrangements for the conference, in conjunction with the Asphalt Association, were made by the following committees: Engineering Committee, Col. Woolsey Finnell, chairman; the Research Committee, F. P. Smith, chairman; Contractors' Committee, L. B. West, chairman; Atlanta Committee, W. A. Hansell, Jr., chairman; Entertainment Committee, Joe Glozier, chairman; Golf Committee, W. B. Carleton, chairman; Reception Committee, R. D. Knale, chairman; Publicity Committee, W. Tom Winn, chairman; Transportation Committee, G. H. Yancey, Jr., chairman; Hotel Committeetee, B. M. Smith, chairman, and the Ladies' Committee, Mrs. R. K. Rambo, chairman.

The selection of the time and place for the next conference was left to the Board of Directors of The Asphalt Association. Among the cities seeking the next conference are the following: Denver, Col.; New Orleans, La.; West Baden Springs, Ind.; Detroit, Mich.; Montreal and Toronto, Canada; Philadelphia, Pa.; Atlantic City, N. J.; Miami, Fla., and Minneapolis, Minn.

SANDS FOR SHEET ASPHALT PAVEMENTS

F. C. Field,
Chemist, Asphalt Association

and

By Prevost Hubbard,
Chemical Engineer, Asphalt Association

Part II

PART I of this interesting paper, discussing methods of distinguishing sands for sheet asphalt pavements, appeared in the December 7th, 1927 issue of Pit and Quarry. It opened with the question "What is a good sheet asphalt sand? Since there is no method for determining the relative toughness of sand grains, it is impossible to construct a curve of maximum density applicable to all sands." Part I included many references to the illustrations appearing here and considerable data are introduced below to give an idea of the suitability of different sands by the stability test.—Editor.

Before making a stability test the specific gravity of the compressed test specimen of asphalt paving mixture is first determined. In determining the maximum stability that can be secured from a given mineral aggregate a number of test specimens containing different percentages of a given asphalt are prepared and tested. The specific gravity of these mixtures of course vary with the percentage of asphalt and the closeness of packing of the mineral aggregate. If the specific gravity and percentage weight of each constituent of the mix are known it is possible to calculate with considerable accuracy the apparent density or closeness of packing of the mineral aggregate and to express the results as voids in the mineral aggregate irrespective of the asphalt which may partially fill or completely fill them. Voids determined in this manner will hereafter be termed V. M. A. to distinguish them from the voids in the total paving mixture which are not filled with asphalt. By varying the percentage of asphalt with a given aggregate it becomes possible to determine not only maximum stability but maximum practical closeness of packing of the mineral aggregate or minimum practical V. M. A.

In carrying out this investigation it was considered highly desirable to work with a wide variety of sand. Authentic samples of typical asphalt sands were therefore first secured and included such products as pit sand used in New York City, Potomac river sand used in Washington, D. C., Lake Erie sand as used in Columbus, Lake Michigan sand as used in Chicago, Platte River sand as used in Omaha, beach sands from Florida and Long Island and a number of sands from other sources. All of the gradings were natural with the exception of those from Florida and Platte River which were mixed products, the latter being prepared to duplicate the so called ideal heavy traffic grading so widely used as a standard.

Each of these sands was combined with a single commercial limestone filler to produce aggregates containing 10, 20, 30 and 40 percent of filler. As 79 percent of the filler passed a 200 mesh sieve the percentage of 200 mesh filler in the final mixtures containing asphalt amounted to approximately 7, 14½, 22 and 29 percent for the respective series. Each of the mineral aggregates was combined with not less than 3 different percentages of 40 to 50 penetration asphalt in preparing specimens for the specific gravity and stability tests.

In order to determine what effect might be produced by variations in shape and texture of grain a large sample of the New York sand was separated into seven sizes by means of the usual standard sieves and as exact a duplicate as possible was prepared of each of the sands obtained from other sources. These duplicate sands were mixed with filler and asphalt to produce duplicates of all of the other mixtures. Over 325 individual mixtures were thus prepared and tested in duplicate and in a few cases, where the checks were not reasonably close or the results were questionable, new mixtures were prepared and tested.

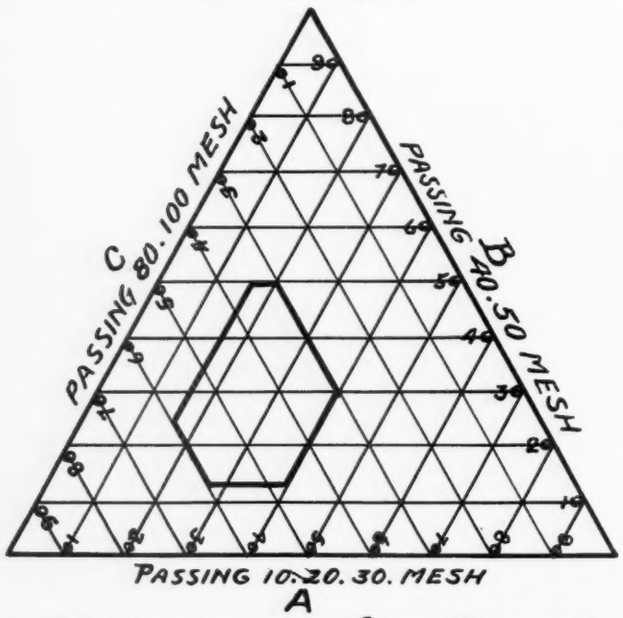
To present and discuss all of the results at this time is unnecessary and impracticable but some of the data will be used to illustrate the facts which are believed to be of most importance. First of all to return to grading and voids, the mesh composition of a so called ideal sand and other sands which produced the minimum and maximum V. M. A. for each of the filler series is shown in Table I with the corresponding V. M. A. of the duplicate pro-

TABLE I

Sand Number	Sand Grading			Filler in Mineral Aggreg.		
	A	B	C	10%	20%	30%
8 Ideal				24.3	20.9	19.2
N. Y. Dupl.	26	43	31	27.7	23.7	21.7
14				22.2	19.4	17.5
N. Y. Dupl.	32	44	24	27.7	22.8	20.5
26				30.8		
N. Y. Dupl.	12	83	5	31.5		
18					26.3	22.2
N. Y. Dupl.	14	58	28		27.3	23.6

duced with New York sand. First of all it will be seen that the so called ideal grading did not produce the lowest V. M. A. in any of the filler series The somewhat coarser but well graded sand No. 14 developed the lowest V. M. A. but the duplicate of this grading with the New York sand using 10 percent filler showed the same V. M. A. as the ideal grading with this same sand. Confirming the previously reported results a relatively high V. M. A. was obtained with sands in which the B group of particles greatly predominated. It is of particular

DIAGRAM 1



THREE COMPONENT SAND GRADINGS.

interest to note that in every comparison the New York sand showed a higher V. M. A. than the sand which it was intended to duplicate, thus indicating an appreciable influence produced by some other factor than mesh composition. A difference of 5½ per cent voids was found between Sand 14 with 10% filler and its New York duplicate. An examination of these sands under the microscope showed both to be fairly rough surfaced but the New York sand was somewhat sharper and more angular in its coarse and intermediate size grains. The visual difference between these two sands would not however, lead one to believe that with the same mesh composition a difference of over 5 per cent voids would be developed.

The relative stability values developed by Sand 14 and its New York duplicate may be of interest to note at this point. With 10 per cent filler both showed good stability but Sand 14 was somewhat higher than its duplicate. Further additions of filler however, produced practically no increase in stability with Sand 14 although the V. M. A. were reduced. On the other hand the stability of the New York duplicate was materally increased by the further addition of filler and with 20 per cent filler in the mineral aggregate the New York duplicate developed over 1,000 pounds greater stability than Sand 14.

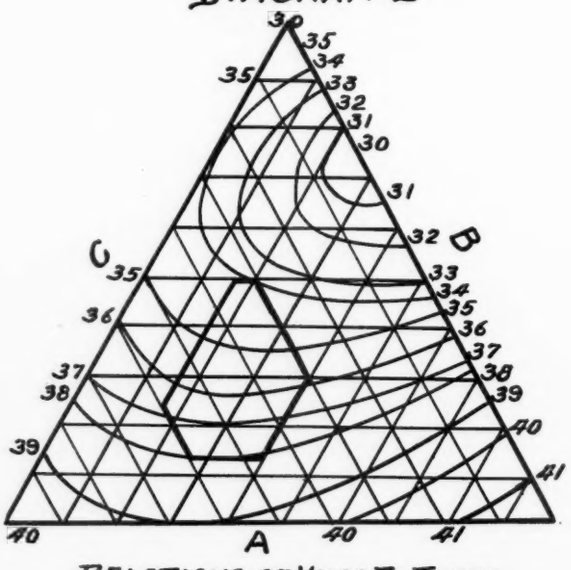
That the V. M. A. per se has no dependable relation to stability was shown by a study of maximum stability values developed by all of the mineral aggregates. It was observed that while there is a general upward trend in stability with decrease in voids for the low per cent filler series, the higher per cent filler series were extremely erratic and if anything tended to show the reverse.

That grading per se cannot be depended upon to fortell the relative stability of asphalt mixtures produced by sands of known mesh composition is illustrated by Fig. 5 and 6. In Fig. 5 a few of the stability values obtained with sands of varying mesh composition mixed with 10 per cent filler are shown on the triaxial diagram. Each set of figures in brackets shows the stability produced by a given sand and by its New York sand duplicate of the same mesh composition. A difference of over 100 per cent is seen to exist between certain sands and their New York sand duplicates. It will be further noted that while the highest stability value is located within the customary specification area the same is true of the lowest stability value. On the other hand relatively high stability values have been developed by a number of sands entirely outside of the specification area. As a matter of interest it may be noted that the same facts were developed by a similar comparison of the 20 and 30 per cent filler series, and confirm the results reported by the authors three years ago in their first experiments with Caster Oil mixtures, before they had developed their stability test to a point where it could be reliably used in studying mixtures containing asphalt.

Figure 6 is of interest in further illustrating the lack of definite relations existing between mesh composition of different sands and the V. M. A. and stability developed by their use is asphalt paving mixtures in which the mineral aggregate contained 10 and 20 per cent of filler. The solid curve shows the so called ideal grading and the broken line curve; a grading entirely different. The two sets of values given for the ideal grading represent two different sands of identically the same mesh composition.

Having shown that there are no relations between mesh composition voids and stability sufficiently definite to enable one to forecast from grad-

DIAGRAM 2



RELATIONS OF VOIDS TO THREE COMPONENT SAND GRADINGS.

ing and void tests whether or not a given sand will produce a stable mixture it will be instructive to study some typical difference in stability which are developed by sands which have been and are now being used in sheet asphalt construction in different parts of the country. For this comparison four sands have been selected namely New York sand, Potomac River sand, Platte River sand and a Florida sand. Stability values of the New York sand regarded to duplicate the other sands have also been included as shown in Table II.

Examination of this table reveals some interesting information. First, it will be noted that the New York and Potomac River sands possess relatively high stability while the Platte River and Florida sands show low stability. Mesh composition cannot be held responsible for the observed differences as in every case duplication of the Platte River and Florida gradings with New York sand developed relatively high stability. That the Potomac River sand has an inherently higher stability than the New York sand is shown by the lower values produced by the latter when it was made to duplicate the grading of the former. With a relatively low percentage of 200 mesh filler it is seen that the natural New York sand develops less than half the stability of the Potomac River sand but over twice that of the Florida sand. Similar differences are seen to exist when other percentages of filler are present. Although the ratios are not exactly the same. The Potomac River sand with 7% of 200 mesh filler in the mix is seen to produce a much more stable mixture than either the Platte River or Florida sands with 22 per cent of the same 200 mesh filler, and about the same as that shown by the New York sand with 14.5% of 200 mesh filler. On the other hand the New York sand with 7% 200 mesh filler in the mix develops

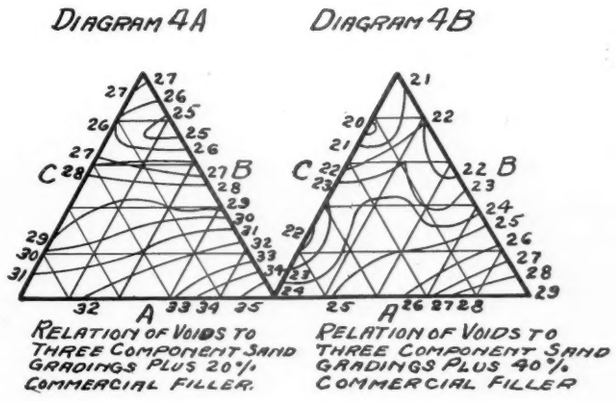
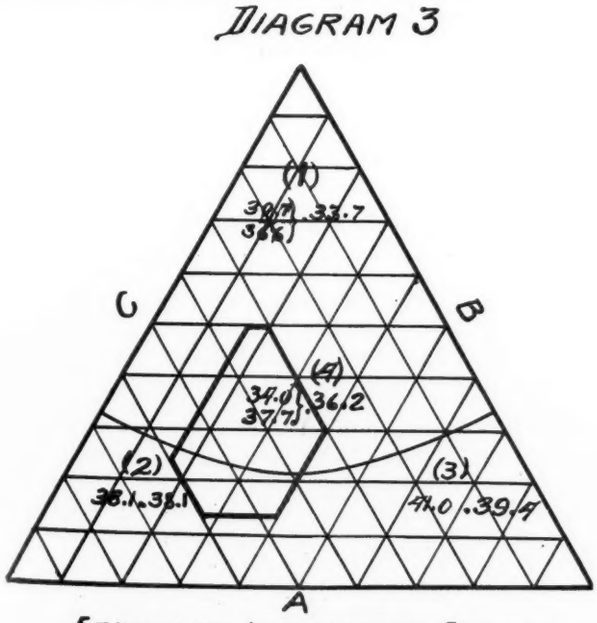


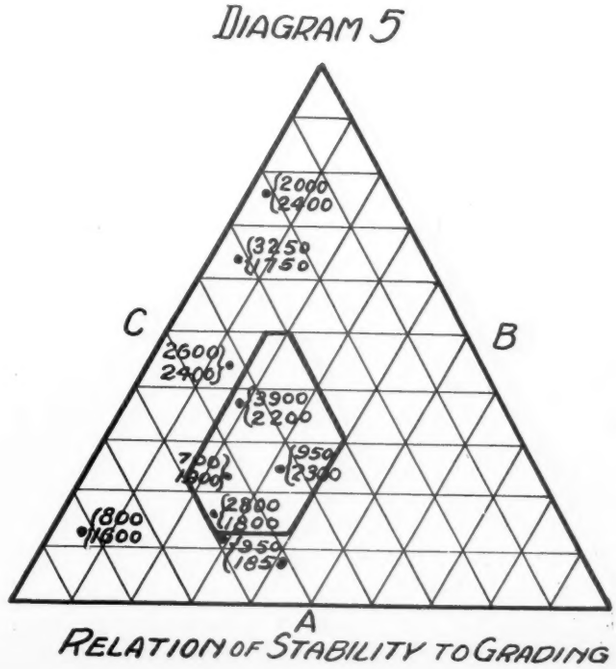
DIAGRAM 4A
DIAGRAM 4B
C
B
A
RELATION OF VOIDS TO THREE COMPONENT SAND GRADINGS PLUS 20% COMMERCIAL FILLER.
RELATION OF VOIDS TO THREE COMPONENT SAND GRADINGS PLUS 40% COMMERCIAL FILLER

about the same stability as the Platte River sand with 14.5 per cent 200 mesh filler.

The causes of most of these observed differences remains a matter of speculation and probably always will as they are undoubtedly the complex results of diffences in grading, voids, shape of grains, surface area, and surface texture which are so interwoven as to make it almost impossible to evaluate them separately.

That surface texture is a factor of considerable importance in connection with stability, is indicated by the much rougher surface of the Potomac River sand than of the Florida sand, but there appears to be no such difference between the New York and Florida sands. Typical grains of these three sands nearly a hundred micro-photographs were made of magnified to 50 diameters are shown in Fig. 7. the sands used in this investigation with the hope that some definite relations might be developed between surface texture, angularity, and stability but the results were in general disappointing. As shown in Fig 8, Platte River sand is composed mainly of relatively round and smooth surfaced grains which could logically be considered to be the cause of its





low stability value. On the other hand the apparant difference in texture and angularity between the New York and Florida sands could hardly be interpreted to indicate their wide differences in stability value found by test.

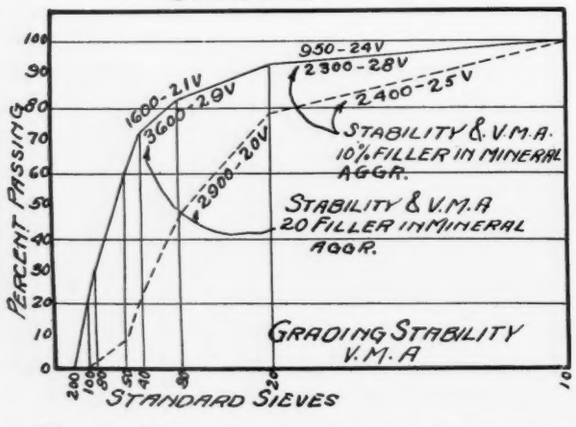
If time permitted it might be interesting to develop what the stability test is able to show about the asphalt carrying capacity of different sands and the relation of surface area to this characteristic. It is believed however, that enough has been presented to show that if the inherent resistance of an asphalt paving mixture to internal movement is an important characteristic, and it is believed that few if any will question this proposition, then by means of the stability test it is possible to evaluate sands for sheet asphalt pavements, more completely and readily than by any or all of the usual tests and requirements to which such sands have been subjected in the past. It should be realized however, that such evaluation is dependent to a great extent upon the character and proportions of the mineral filler and asphalt which are to be associated with the sand in the finished mixture. As an illustration while the Florida sand developed a very low stability until combined with as high as 30 per cent of a given limestone filler it was found possible by using another readily available filler in considerably less amount to materially increase the stability of mixtures in which it was used.

TABLE 2

Relative Stability Value of Sands

Sand	Sand Grading			Filler in Mineral Aggreg. Pass. 200 Mesh in Mix		
				10%	20%	30%
	A	B	C	7%	14.5%	22%
1						
New York	27	60	13	1700	3800	4000
10						
Potomac				3900	4600	5500
N. Y. Dupl. ...	38	43	19	2200	3400	4100
8						
Platte Riv.				950	1600	2200
N. Y. Dupl. ...	26	43	31	2300	3600	4300
24						
Florida				700	1200	2000
N. Y. Dupl.	24	53	23	1900	3000	3900

DIAGRAM 6



The problem of evaluating a sand by means of the stability test therefore, becomes localized and it is believed that when so treated many sands which have heretofore been considered unsuitable may be found entirely satisfactory for use in sheet asphalt construction. To illustrate by a specific example, two local sands may be readily available for use on a given job. Let us suppose that Sand A which is considerably cheaper than sand B does not exactly meet the usual specifications for mesh composition but is clean and reasonably sharp and rough. Sand B falls within the specification limits but is smoother and the grains are more rounded in character. Let us also suppose that two mineral fillers X and Y are locally available at approximately the same price. Upon making up trial mixtures of these sands with filler and asphalt it may be found that Sand A with fifteen per cent of filler Y produces as high a stability as Sand B with twenty five per cent of either of the fillers and that the sand A mixture will also carry the highest percentage of asphalt without loss in stability. If the voids in both compressed mixtures are satisfactorily low it is evident that the use of Sand A is to be preferred not only from the standpoint of producing the most highly weather resistant mixture but also because of its probably greater economy.

Numerous other hypothetical examples might be cited to illustrate the serviceability of the stability test in evaluating sand but time does not permit. The authors have found it particularly useful in utilizing a single available sand to best advantage when the sand was not of the most satisfactory character. In such cases the problem becomes one of selecting the most suitable filler and consistency of asphalt for use with this sand to produce a mixture of satisfactory stability.

In conclusion it should be said that when evaluating a paving mixture by means of this stability test the percentage of voids in the total compressed mixture should be given consideration and, other things being equal, preference should be given to that mixture which carries the highest percentage of asphalt and shows the lowest percentage of voids when thoroughly compressed. By so doing, greater insurance will be obtained against weathering disintegration and cracking.

Magnesium in Portland Cements

The following factors affecting the determination of small quantities of magnesium in the presence of large amounts of ammonium salts were investigated: 1. The influence of various quantities of ammonium salts. 2. The influence of dilution of the solution upon the amount of the estimated $Mg_2P_2O_7$. 3. The influence of various methods of precipitation, especially hot and cold. Working with hot solutions these results were obtained: 1. When magnesium is present in large amounts, in a small volume of solution the ammonium salts have no practical effect. 2. But if the Mg is present in small quantity and the volume of the solution is large, the ammonium salts inhibit the precipitation.

EXPERIENCE PROVES MOST VALUABLE ASSET IN GRANITE BLOCK BUSINESS

SOMETHING like 25,000,000 granite paving blocks are made each year in New England. Naturally some of the concerns producing these are larger than others and some are older than others but most of them seem to be in fairly prosperous circumstances. A new operation of this kind was started in Waldoboro, Maine, in the spring of 1925 by Mr. William Grant who was formerly superintendent for Booth Brothers for 35 years and who has been in the granite business since he was seven years old. Judging from the looks of his operation, Mr. Grant has profited well by his long experience.

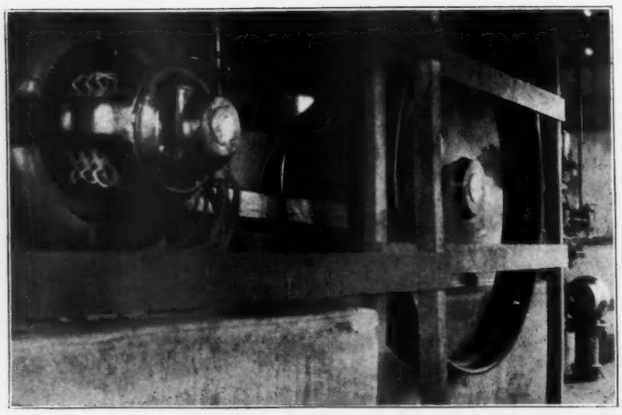
The production of this enterprise is from half a million to 600,000 blocks per year. New York City is the principal market but Bath, Portland and Rockland, Maine, also use them. Shipments are made by water from Rockland, 18 miles away, to which place the blocks are taken by railroad.

The appearance of the quarry is shown in the illustrations. A counter weighed block derrick is used which makes for speed and the saving of labor. An air hoist is used to swing the derrick and a Maine electric hoist with Cutler Hammer starting equipment to raise the blocks. Livingston drill and Ingersoll Rand jack hammers are used for drilling.

About 40 men are employed of which 25 are paving stone cutters. The latter are provided with Livingston pneumatic tools. In fact many of the supplies are purchased from this concern which is conveniently located in Rockland.

Drilling with Air Drill

Mr. Grant, Right, and One of the Block Cutters



Motor Driven Air Compressor

As will be seen from the illustrations the whole place is kept in very neat condition. For instance, the finished blocks are carefully piled up around each cutter and the large quarry blocks are placed so as to be convenient for him to work on. The blacksmith shop where drills are sharpened and minor repairs made is free from litter and is a very clean place inviting careful work. The compressor house is truly a model from the standpoint of being shipshape and of good installation practice, both electrical and mechanical. The 14 x 12 Ingersoll-Rand compressor is mounted on an elevated concrete base as shown in the illustration. It is driven by a 75 h.p. General Electric motor on the same foundation. The outside feed wires are brought in through conduit to a Trumbull safety disconnect, then through a General Electric polyphase meter to the General Electric magnetic switch or automatic

(*Continued on page 97*)

Moving a Large Block Just Broken Loose

General View of Quarry, Mr. Grant at Right

SIXTH ANNUAL ASPHALT PAVING CONFERENCE LARGEST AND MOST ACTIVE

MEETING in Atlanta, Georgia, November 28 to December 3, last, the Sixth Annual Asphalt Paving Conference, held under the auspices of the Asphalt Association, and the Association of Asphalt Paving Technologists went to record as favoring many important matters concerned with the expansion of the road building program of the nation. The conference was the largest and most beneficial of its kind ever held, the registered attendance being 510 and the program being the best ever arranged in point of technical discussion. Among the leading speakers were Thomas H. MacDonald, chief of the United States Bureau of Public Roads and Frank B. Curran, chief of the Highway Section, Bureau of Foreign and Domestic Commerce, United States Department of Commerce, both of whom brought a message of great importance relative to the expansion of the asphalt industry and the development of asphalt for paving.

The conference, adopted the report of its resolutions committee, in favor of Federal Aid during 1930 and 1931 in highway construction at the rate of $75,000,000 per year; in increasing the limit of $15,000 per mile Federal Aid to 100 per cent of the cost of those projects forming necessary connecting links on highways in public land states having a population of less than ten persons to the square mile; salvaging old roads and paving with low cost pavements the secondary and tributary highways; urging the design and construction of wider streets and roads in and around the congested centers; against the defacement of danger signs along the highways; in favor of legislation prohibiting advertising signs on highway rights of way and the discouragement of billboards and signs along the highways on private property; urging Congress formally to invite the Permanent International Association of Road Congresses to meet in the United States in 1930, memorializing Congress, also, to authorize and finance American official participation in the Second Pan American Highway Conference at Rio de Janeiro in July, 1928; commending the Department of Commerce for its efforts to promote abroad the construction of roads with American materials, methods and machinery; thanking the American Society for Municipal Improvements for an invitation to meet jointly with it in Detroit next year; and memorializing Congress to repeal the war-time taxes on the sale of automobiles.

The resolutions committee consisted of the following: J. T. Bullen, Shreveport, La., chairman; A. K. Vickery, Denver, Colo.; H. C. Ehrenfels and L. M. Law, New Orleans, La.; B. L. Boye and Fisher Jones, New York, N. Y.; V. B. Catchings, Raleigh, N. C.; W. T. Headley, Philadelphia, Pa.; H. L. Howe, Rochester, N. Y.; C. S. Lee and Chas. M. Upham, Washington, D. C.; H. W. Skidmore, Chicago, Ill.; E. S. Spencer, St. Paul, Minn.; W. A. Hansell, Atlanta, Ga.; M. P. O'Brien, Decatur, Ill.; and H. D. Williar, Baltimore, Md.

Thomas H. MacDonald's address dealt with highways in the making of fundamental policies of the Bureau of Public Roads, damage to highways in flooded areas and various other pertinent matters. The speaker declared that observation and experience as a result of the floods along the Mississippi and in New England has strengthened confidence in the ability of modern highway construction to withstand unprecedented flood conditions. The losses on Federal Aid roads in Vermont, for instance, he said, was only 5 per cent in proportion to the Federal funds invested. The Federal Aid roads in the flooded districts of the Mississippi Valley withstood the ravaging waters equally as well. "The program of this nation in building highways," said Mr. MacDonald, "has had no parallel in all past history. The cumulative loss to the nation now of inadequate highways is prohibitive. At the end of this year we estimate that there will be in service on the highways about 23,300,000 motor vehicles, an increase of about 6 per cent over last year. There will have been consumed during the year according to our present estimates 10,720,000,000 gallons of gasoline, an increase of 9 per cent over last year. If there was an average operation of 12 miles per gallon, the combined rural highway and city street costs for the year were about one cent per vehicle-mile. At a retail price of 20 cents per gallon, the value of the fuel consumed is $2,144,000,000 which is more than one-third the gross operating revenues for the fiscal year ended last June, of all the first-class railroads of the United States, constituting 95 per cent of the total railroad mileage. Also it is double the income for all rural highway purposes. The use of gasoline by the individual motor car is estimated now at 460 gallons for the year, an increase of 3.6 per cent over last year. It appears, therefore, that in addition to a 6 per cent increase in the number of vehicles in use, the use of the vehicles themselves is increasing. The indicated total utilization of our rural highways and our city streets approximates, for this year, 128,000,000,000 vehicle-miles, a total so far beyond our comprehension that it fails to assist us greatly in visualizing the physical dimensions of the highway construction and maintenance necessities.

"The tremendous mileage of two million miles of earth roads is composed largely of roads found along the section lines principally in the agricul-

tural states. There is no question now but that a very large part of this milage could be turned back into farm lands with corresponding public and private benefits. The traffic over the roads does not justify their existence as public highways. Surfacing has been applied to 274,910 miles. Of this, 82.3 per cent is of the lower types, which may or may not be transitory. In this class lie many miles of roads within metropolitan districts which will have to be improved to a high type.

"It must be evident from this discussion that two general policies are sorely needed in the management of local roads: First, planning commissions for metropolitan areas to lay out a system of roads for the area as a whole, although there will be found in such areas an astonishing number of civil jurisdictions. Cook County, Illinois, and Cuyahoga County, Ohio, transitory surfaces sustain this fact. Second, rural planning commissions are needed to work in conjunction with the state highway department in the planning of county and feeder roads for the purpose of planning a system of public highways that will reach and serve the agricultural population with a minimum possible mileage.

"The surfacing of the state systems," continued Mr. MacDonald, "is proceeding at the rate of approximately 20,000 miles per annum and the surfacing of the local roads is proceeding at the rate of about 25,000 miles per annum, but the percentage of the types are not changing materially. There are certain logical conclusions of particular interest to the asphalt industry which may be summarized as follows: First, based on an annual utilization of the highways of 128,000,000,000 vehicle-miles, the annual passenger mileage is approximately 2,880,000,000 miles. This is not less than eight times the passenger mileage of the steam railroads in 1925, and is indicative of the predominating use of the highways by the people. The annual loss of surfacing from the low type roads, plus the dust nuisance means, that more effective materials must be found and more largerly utilized both for holding these surfaces and for dust suppression. This is a field for bituminous construction.

"Second, there is such a tremendous mileage of roads initially improved on which the surface is not now adequate that a low type of supplemental construction must be developed which can be adequately maintained. As indicative of the possibilities in this field, we have a demonstration of the finest crushed rock surfaces in the west. The processing with bituminous treatments gives promise of high class service under moderate traffic at a reasonable annual maintenance cost. Furthermore, a type of maintenance is possible that renews the original smooth riding qualities of the road. It has already been demonstrated that these surfaces can be scarified and a small amount of additional material added and that the work can be done on a quantity basis, and, which is all important, at a low cost. There may be difficulties with this type of construction, but it gives such promise that the asphalt industry, both engineers and contractors, can well afford to devote thought and effort to its perfection.

"Third, there are long mileages of both the state highway and local highway systems, particularly in the regions west of the Mississippi River, on which the only hope now apparent for first class highway service lies in the development of bituminous construction. Without criticising the efforts that are being made toward the perfection in detail of the standard asphaltic mixtures for pavement construction, the attention of the industry is directed toward the desirability and necessity of developing types of construction that can be laid more cheaply than the standard types and that will prove adequate. This may very well mean making a larger percentage of the product available for use in the lower types of construction, and to do this not only the processes but the equipment, and even the material itself, must be adapted to this purpose.

"Fourth, again, without thought of overlooking the desirability of the more durable types of construction which have long been established as standard, the attention of the industry is directed toward the overwhelming physical problem confronting the country, which cannot be met quickly by the relatively small mileages of the high cost construction that may be built with the present income from year to year. It does not appear impossible to develop processes, and the bituminous processes seem most adaptable for the purpose, that lend themselves to complete overhauling largely restore the roads to its original condition without impossible expense. Students of highway finance must be impressed with the fact that it is the annual cost of providing adequate highway service that is the important item, and the field of possibilities in bituminous construction has been only partially developed.

"Fifth, finally the performance of many of the older bituminous macadam roads, particularly in the northeastern states and abroad, provides confidence that this type of construction can be used under heavy traffic, provided the design and maintenance are adequate. In this field there seems to lie the possibility of more closely controlled manufacturing processes, coupled with changes in design that would insure more uniform and more satisfactory results."

"Your splendid organization and the bureau which I have the honor to represent here, have much in common," said Frank B. Curran of the Department of Commerce, in his address. "You are engaged in a laudable effort to promote highway development and the interests of a great industry. The Bureau of Foreign and Domestic

Commerce is engaged in promoting American Industry in general, and has a special interest in highway development and its ever increasing effect upon commerce. The problems handled by the Highways Section perhaps come closest to the work of the Asphalt Paving Conference. During the last four years we have made an excellent collection of data on highways and highway transportation abroad, and every mail now brings us reports from far outlying posts, of new roads planned or under construction, of larger appropriations of highway development and of new opportunities for American trade resulting from road improvements.

"Recently I had the good fortune to accompany a party of highway officials from Delaware who traveled to North Carolina to study the low cost sand-asphalt roads which have been so successfully developed there. Everyone I questioned on the trip gave me specific examples of increased prosperity of cotton and tobacco growers, banks, railroads and business firms, resulting directly from the improvement of roads in that state and pointed out beautiful new rural schools which were a far cry from those of a comparatively few years ago. In the United States we have a mile of road for every forty persons. Brazil has only a mile to 944 persons. Conversely, every person in the United States has 44 yards of road to walk or ride upon, while the Brazilian must be satisfied with less than 2 yards. We have a mile of road in every square mile and a quarter of area, and Brazil has only a mile in each 10 square miles. Chile has one mile of road to every 150 persons, or each Chilean has the use of 12 yards of road. Chile has a mile of road in each 12 miles of area. Last year Chile spent approximately 48 cents per capita on roads; Peru spent less than 25 cents; Uruguay $1.09, and Salvador 30 cents, while the United States spent almost $11 per capita.

"All the world wants roads and all of the world looks to the United States for the best examples of modern highway development. Therein lies a wonderful opportunity for American skill and initiative to help in a work which will add immeasurably to the peace and prosperity of the world. In many countries road construction is limited by lack of funds, and the problem is to build a large mileage at low cost. Is not that problem of tremendous significance to the asphalt industry?

"In the Bureau of Foreign and Domestic Commerce we have welcomed the opportunity to cooperate in the development of highway transportation abroad. Every mail is carrying to our foreign offices data of all kinds on American methods of road construction, financing and maintenance, furnished by the Bureau of Public Roads, the Highway Education Board, The American Association of State Highway Officials, The Asphalt Association, and others. In all ways we are trying to make our participatation in the highway work abroad as effective as possible, and we do not hesitate to call on our friends for assistance. I would like to return to Washington, gentlemen, with the assurance that we may count upon you, members of the Asphalt Paving Conference as friends—all of you can help. Manufacturers of paving materials and machinery, your products are needed abroad and you owe to those abroad working for better roads to let them know that you can supply their needs. Engineers, highway officials, contractors, there is need of technical knowledge and skill and ability to handle large construction problems. All the resources of the Bureau of Foreign and Domestic Commerce, the knowledge and skill of its staff of experts here and abroad are at your disposal. Whenever we have a request for information relative to the various types of asphalt construction, for standard specifications, or relative to the use of asphalt machinery or whenever we find that there is a market for your materials, services, or machinery, may we count on your prompt cooperation?"

Both Mr. MacDonald and Mr. Curran addressed the conference at its fourth session on Tuesday afternoon. At the opening sessions on Monday, addresses were delivered by J. S. Helm, president of the Asphalt Association, New York City; L. G. Hardman, Governor of Georgia, and J. M. Ragsdale, Mayor of Atlanta, the latter two addresses being in the nature of official welcomes. A most interesting address was made by H. W. Skidmore of Chicago, president of the Association of Asphalt Paving Technologists. Chas. M. Upham, business manager, American Road Builders' Association, Washington, D. C., gave an address on asphalt road equipment, and C. M. Conner, chairman, Low Cost Improved Roads Committee, Highway Research Board, National Research Council, Washington, D. C., presented a survey of the surface treatment field with particular reference to asphaltic materials.

(*Continued from page 94*)

circuit breaker and from that through conduit to the Western Electric controller and resister. General Electric push control has been mounted on the wall in a convenient location. The building looks neat and tidy in the picture and it is. No preliminary "neating up" was done while the camera was adjusted.

In fact the whole operation is an interesting example of what a competent and experienced executive can do if he is not afraid of work and there was no doubt about it—Mr. Grant was everlastingly on the job, although in a way which seemed to inspire the confidence and respect of his men, rather than to antagonize them.

PIT AND QUARRY FOREIGN DIGEST

Aggregate for Concrete Road Construction

Crushed gravel makes an excellent fine aggregate and gives good wearing qualities. In this respect, it is better than uncrushed gravel. Pea gravel is not suitable. The presence of more than 5% of silt must be regarded as dangerous. In a fine sand loam or clay, it is likely to reduce the strength. In a coarse sand not more than 5% should be permitted. For coarse aggregate the chief materials used are granite, whinstone, basalt, limestone, gravel, sandstone, slags and clinker. Granite is an excellent aggregate. It must be from impurities such as iron sulphides or similar substances. Basalts are hard enough and not brittle and may be substituted for granite if they are cheaper. Limestones of high gravity form very suitable aggregate. The fine dust must be absent or serious loss of strength will result. Gravel forms a satisfactory aggregate where the proportion of sandstone is not too high. Sandstone may be used if mica is absent. Cold blast slags from steel works are usually suitable, but this is by no means true of all slags. Clinker (cinders should not be used if particles of coal are present). R. A. B. Smith (Conc. & Const. Eng. November 1927).

Plaster of Paris for Dental Purposes

Dental plaster is largely the hemi-hydrate, but is likely to be a complex and variable mixture. However, with certain types the expansion on setting is about 0.3%, but is increased up to 1% by stirring after setting has begun or by the addition of previously hydrated plaster. Expansion can be reduced to a negligible amount by the use of a potassium salt or borax to prevent too rapid setting. Sodean and Gibson (British Dental Journal, 1927).

Cement in Hydraulic Agglomerates

The estimation of the total lime in the cement by use of the method involving the 10% ammonium chloride solution. The analysis for moisture is made by heating the material in a muffle furnace at 450 degrees C., at which temperature the calcium carbonate is not decomposed. The method of calculating the cement content and the hydraulic modulus from these figures is not free from objection. G. Gallo (Giorn. Chim. ind. appl. 9, 313-317, and C. Nov. 9, 1927).

Concrete and Mortar

Facing glazing and building material has the following composition: 1 cubic yard of waste from iron mines, 4 hundred weight of cement, 1 pint of paraffin oil and 2 oz. naphtha. For producing a building material, the ingredients are passed through a ¼-inch sieve, but for the facing or glazing material they are ground finely in a mill and the plastic mixture applied with a stiff brush. J. & W. J. Howard (British Patent 276, 836).

Chemical Decomposition of Cements

Chemical reagents may decompose the mortar, either by solution of a constituent or by combination with the ingredients. In the case of decomposition by combination of foreign salts with a constituent of the cement, a characteristic "blowing" occurs, as in the case of decomposition by means of caclium sulphate. A combination of the calcium sulphate with the calcium aluminate of the cement takes place, forming the sulphoaluminate of Candlot. The mechanism of this decomposition is roughly analogous to the mechanism of the slaking of lime. When water is added to anhydrous substance (like quicklime) in quantity insufficient for a solution, this reaction is always accompanied by blowing, which destroys the cohesion of the mortar. The same phenomenon occurs with calcium sulphate and cement. If the calcium sulphate reacts with an aluminate in which the alumina has not been completely dissolved, blowing takes place, as in the case of unfused aluminous cement. But if the calcium sulphate combines with the aluminate in soluble form, blowing does not occur, as in the case of fused aluminous cement. This theory can be generalized. Every reaction which takes place between solid salts without previous solution, has a deleterious effect upon the strength. Reactions between dissolved salts are without ill effect on the mortar. This theory holds true in the reaction of fat lime on anhydrous calcium aluminate, but does not stand up on the hardening of blast furnace cements. Blast furnace slag seems to harden with fat lime, without previous solution. H. Lafuma. (German Chemical Society Meeting, Berlin, November, 1927. Special Report).

Loss of Weight in Burning Cement

The determination of the loss of weight in the burning of cement is theoretically a very simple process, but in practice much care must be exercised to obtain exact results. For example, cements containing blast furnace slag and which are burned in an oxidizing atmosphere of the furnace undergo a change in which part of the calcium sulphide changes to calcium sulphate. This tends to counteract the loss in weight of the water and carbon dioxide. Another source of error, common to all cements is the action of other materials, such as coal, which evolves reducing gases which may react with calcium sulphate and change it to the sulphide. Or it may partially reduce the ferric to ferrous oxides. Furthermore, cracks in the furnace, the

position of the crible, etc., may affect the results. Calcination in a cement muffle furnace is recommened and protection from coal or coal gas is most necessary. G. Baire (Meeting German Chemical Society, Berlin, Nov., 1927, Special Report).

Slip Calculations

In determining the amounts of various high silica clays when more than one is used with limestone, the following formulae apply, when the silicate modulus is fixed:

1. $A = \frac{m.3 - c}{c. - m.s}$
2. $n = \frac{Si}{R}$
3. $Si' = \frac{Si''' + H.Si''}{1 + H}$
4. $Si = \frac{Si' + A.Si''''}{1 + A}$
5. $R' = \frac{R''' + H.R''}{1 + H}$
6. $R = \frac{R' + A.R''''}{1 + A}$
7. $S = Si' + R'$
8. $C = \frac{Ca''' + H.Ca''}{1 + H}$

$m = \text{Hydraulic modulus} = \frac{CaO}{SiO_2 + R_2O_3}$

$n = \text{Silicate modulus} = \frac{SiO_2}{R_2O_3}$

$R_2O_3 = Al_2O_3 + Fe_2O_3$.

The unknown quantities are:

H = Parts of clay No. 1 to be mixed with 1.0 part clay No. 2 in clay mixture M.
A = Parts of Limestone per 1.0 part clay mixture M.
S = $SiO_2 + R_2O_3$ in clay mixture M.
C = CaO in clay mixture M.
Si = SiO_2 in slip.
R = R_2O_3 in slip.
Si' = SiO_2 in clay mixture M.
R' = R_2O_3 in clay mixture M.

The known quantities are:

m = Hydraulic modulus.
n = Silicate modulus.
S_1 = $SiO_2 + R_2O_3$ in limestone.
C_1 = CaO in limestone.
Si'' = SiO_2 in clay #1.
Si''' = SiO_2 in clay #2.
R'' = R_2O_3 in clay #1.
R''' = R_2O_3 in clay #2.
Si'''' = SiO_2 in limestone.
R'''' = R_2O_3 in limestone.
Ca'' = CaO in clay #1.
Ca''' = CaO in clay #2.

By substitution and elimination in the 8 equations above, H, the relative amount of 1 clay to the second becomes:

$$H = \frac{[m\,(Si''' + R''') - Ca'''] \,.\, [Si'''' - n.R''''] - [n.R'''' - Si''''] - [Si'''' - n.R'''] \,.\, [C. - m.S.]}{[m\,(Si'' + R'') - Ca''] \,.\, [n.R'''' - Si'''']}$$

From which H may be calculated. An example is given. Dr. C. Helmholz (Zement, November 17, 1927).

Trend in Building Materials

Pre-cast concrete blocks are superior to bricks which will not long remain cheaper than the newer material. Whatever defects are shown today by reinforced concrete are expected to disappear when rustless steel becomes available at a low price. Illustrations show the ability of concrete to follow past architectural styles. Reinforced concrete is particularly good for the newer vertical effects. E. L. Cotterell (Reported by Editor Structural Engineer, December, 1927).

Changes of Cement During Hardening

The rapidity with which cement combines with a large amount of water determines its quality as a hydraulic mortar. For this determines the rapidity with which the greatest compactness and therefore its greatest compression strength is reached. The difference in gravity of a cement at 24 hours and at 48 hours contact with water measures its value, the greater the decrease in gravity; i. e., absorption of water, the greater the strength. (C. Zamboni Giorn. chim. ind. applicate, 8, 469-472, and C. A.).

Plastic Yield and Shrinkage of Concrete

The colloidal conception of the constitution of concrete and the known properties of inorganic colloids adequately account for all the observed properties in connection with the shrinkage, hardening and plastic yielding of concrete. Apart from the high compressive stress in longitudinal compression steel, which calls for greater care in the provision against buckling, there is no reason to suppose that reinforced concrete structures are less safe than hitherto has been supposed. Nevertheless the ultimate deflections must be expected to be much greater than those indicated by short time tests and will increase over long periods. Reinforced concrete structures with stresses inside those allowed in good practice continue to deflect without change of load or temperature, a result due partly to shrinkage and partly to plastic yield. However, such structures are not dangerous on this account when properly designed, but care is necessary in binding compression steel. O. Faber (Conc. & Const. Eng. November 1927).

Blast Furnace Slag as Railway Ballast

Blast furnace slag in Germany has a composition within these limits: 31-36%, SiO_2; 9-12% Al_2O_3; 0.3-0.8% FeO; 1-3.5% MnO; 36-43% CaO; 4-10% MgO; 0.1-0.3% SO_3, 1-2% S. and 0.-0.3% P_2O_5. It is slightly poorer on the railroad track than basalt in its resistance to frost and crushing, but is better than granite. The rusting of iron is somewhat accelerated during the first year, but thereafter it has no effect. Buchartz & Saenger (Stahl u. Eisen 47, 1663-1664, 1927).

INTIMATE NEWS OF MEN AND PLANTS

North American Cement Plans Improvements

Expenditures totalling $750,000 have been agreed upon and contracts let for improvements to the Hagerstown, Maryland, plant of the North American Cement Company. The following contracts have been definitely placed according to latest information. Waste heat equipment is being supplied by the Edgemoor Iron Company, the Foster Superheater Corporation and the Green Fuel Economizer Company. The building construction and concrete work is being done by the J. B. Ferguson Company; electrical equipment is being installed by the General Electric Company; condensing equipment by the Worthington Pump and Equipment Corporation; and all piping is by the W. K. Mitchell Company.

California Plant Damaged By Fire

A recent fire, caused by a short circuit, is reported to have resulted in considerable damage to the Colton, California plant of the California Portland Cement Company. The amount of damage and the equipment destroyed will be reported by the California Edison Company which is making an inspection of the property.

Some Tile Order

General Motors has recently placed an order for 200 carloads of roofing tile with the Federal Cement Tile Company, Hammond, Indiana, according to reported information. This tile is to be used on the proposed Oakland automobile plant at Pontiac, Michigan.

Olympic Portland Develops Quick Hardening Cement

During the month of November, the Bellingham, Washington, plant of the Olympic Portland Cement Company made extensive tests with its "Velo," a quick hardening cement in the development of which there has been considerable research and a number of tests, by F. L. Smith and Company.

During November, the tests show that "Velo" had a tensile strength, when 24 hours old, of 370 pounds per square inch. On November 26th, a piece of concrete paving 7 inches thick was poured and finished in the afternoon. After 24 hours, it showed a compression strength of 3,000 pounds per square inch and more than 6,000 pounds after 48 hours.

New Incorporations

Epling Sand & Gravel Co., Inc., Gallipolis, Ohio. M. S. Epling. $50,000.

Western Limestone Products Co., 334 Peters Trust Bldg., Omaha, Nebr. 50,000 n.p.v.

Stark Sand & Gravel Co., Edgefield, Octa P. O., Ohio. 1000 shares n. p. v. M. M. Smith, Ruth Stone Smith, Ida M. Smith, W. A. McIntyre.

Kenvil Sand & Gravel Co., Kenvil, N. J. $125,000.

Eaton Canyon Rock & Sand Co., 2000 shares n.p.v. E. E. Craig, J. M. Townsend, A. L. Raughley. (U. S. Corp. Co., Dover, Del.)

Cobbleskill Limestone Products Corp., Cobbleskill, N. Y. $600,000. Arden L. Norton, Jesse V. S. Norton, Frank P. Norton.

Bird Lime & Cement Co., San Antonio, Tex. $10,000. Mat M. Bird, 1922 Blanco Road; J. S. MacManus, 1610 Schley St.; William A. Tarillion, 618 Mission St.

Southern Asbestos Co., Lincolnton, N. C. $1,250,000.

Twin States Sand & Gravel Co., Trenton, N. J. E. M. Fisher, D. G. Eisenbach, Attorney, Louis Gerber. $250,000 pfd.; 5000 shares com. n.p.v.

Clayton Sand Co., Clayton, N. Y. $75,000. Oliver C. Bogenschultz, Clarence F. Hall, William S. Brooks, Lawrence R. Kittle, Edward J. Brown.

Agricultural Muck Corp. Sanford, Fla. $25,000. W. E. Stewart, A. E. Stewart.

Muldoon Fullers Earth Corp., Houston, Tex. $25,000. L. D. Brown, First National Bank Bldg.; Mary A. Brown; E. C. Alley.

General Minerals Corp., Chula, Va. $100,000. Waldo H. Jones, Chula; Lyle N. Gillis, James H. Gillis, Alexandria, Va.

Virginia Minerals Corp., Boxley Bldg., Roanoke, Va. Abram P. Staples, Marie Low, Curtis Simpson.

Western Limestone Products Co., care of Swarr, May & Royce, David W. Swarr, Omaha, Nebr. 50,000 shares n. p. v.

Waterford Sand & Gravel Co., Ltd., Toronto, Ont., Can., $250,000.

Crystal Sand & Gravel Co., Battle Creek, Mich., $50,000 and 100 shares n. p. v. J. B. Sperry, H. W. Miller, N. A. Cobb.

American Traverstone Co, Milwaukee, Wis., 100,000 shares, $1 each; 1,000 shares, $100 each. W. M. Culp, Hugo Effenberger, Wm. Dressen. Travertine stone.

Child-Heath Sand Co., Bridgeton, N. J. 5,000 shares n. p. v. Douglas V. Aitken.

International Bitumen Co., Ltd., Edmonton, Alberta, Can. To develop bituminous sand deposits.

Brouillet Sand & Gravel Co., Ltd., Montreal, Que., Can., $30,000.

Friend Sand & Gravel Co., Richmond, Va., $15,000 to $25,000. Geo. W. Shuster, Philadelphia, Pres.; W. I. Cox, Sec.; Thomas Whyte, J. Gordon Bohannon. Sand and gravel dredging.

West Baden Whetstone Co., West Baden, Ind., $1,000. James A., Louis J., Mary E. Chaillaux. Quarry whetstones and abrasives.

Union Lime Co., Portland, Ore., $50,000. B. P. John, Helen John, R. W. Turpin.

Millstone Granite Quarries, Inc., Millstone, Conn. David J. Bettini, Quincy, Mass., Pres.; Pilade Paladini, Sec'y-Treas.; Geo. Carroro; Felice Poggi.

Cadillac Stone Co., 7261 Nuerenberg Ave., Detroit, Mich., $70,000.

Florida Sand Corp., Bartow, Fla., $500,000. S. D. Gooch, M. E. James, B. C. Wilson.

Clarence Pratt Helps an Excellent Idea

The largest living outdoor Christmas tree in San Francisco was lighted with 250 colored electric lights December 17th when a large sixty foot cypress tree in front of the Shriners Hospital for Crippled Children on Nineteenth Avenue was lighted. The members of Mt. Davidson Lodge of Masons, located west of the Twin Peaks wired the tree and did the decorating under the direction of a special committee, consisting of Clarence F. Pratt, of the Pratt Material Company, Henry J. Brunnier, Fernando Nelson, Alfred H. Nicoll and Fred W. Buzzell.

Some of the special features of the program were the bugle call by Mt. Davidson Troop of Boy Scouts, from the west of Twin Peaks district; pressing the electric button to light the tree by Miss Lucile Kemp, daughter of the Master of Mt. Davidson Lodge of Masons; and the assembling of the crippled children in the hospital corridor.

The Christmas tree was lighted each night until after New Years so that the sixty little crippled children, including those lying in bed, could have two weeks of added pleasure. The public was invited to the turning on of the lights and participated in the outdoor program.

New Crushing Plant for Fort Smith

The City of Fort Smith, Arkansas, has granted a permit to the Kelley Trust Company to erect a crushing plant on the site of the old plant formerly operated by the Fort Smith Light and Traction Company. Plans and specifications are being drawn for a plant of five hundred tons daily capacity.

Primarily this crushing plant is being erected to supply the stone for one hundred miles of concrete highway now under construction adjacent to this quarry site by the Arkansas Highway Commission. In connection with this plant a considerable area of land has been acquired for a pipe yard and a plant for the manufacture of re-inforced concrete sewer pipe, cement blocks and cement roofing tile.

Plans are also being drawn for a crushing plant of two hundred tons daily capacity to be located on Highway Number 71 and the Frisco Railroad about fifty miles from Fort Smith to supply a demand of the Highway Comission for stone in that vicinity. Fred E. Johnston, consulting engineer at Sallisaw, Oklahoma, is supervising the plans and purchases of material for the latter enterprise, which includes a lime plant for the manufacture of agricultural hydrated and commercial lime.

Illinois Association Meets to Discuss Highways

The Illinois Association of Highway and Municipal Contractors held its twenty-first annual meeting in the Hotel Sherman, Chicago, December 13, 14 and 15. Among the very interesting papers read and addresses delivered, one of special interest to everyone was a short and comprehensive address on the "Possibilities of Gas Tax" by D. O. Thomas, county superintendent of highways, St. Clair County, Illinois.

Mr. Thomas stated that "the State did the 'handsome' thing when it passed the present law. Persons who get the benefit of the improved roads should pay the bill and mileage, which is a guide to the amount you use the highways, may be calculated from the amount of gas consumed," said Mr. Thomas. "Of the present cost of roads, in most instances, the general property owner is paying 60 per cent while the automobile and truck users are paying only 40 per cent."

Mr. Thomas believes that condition should at least be reversed. He believes that the gas tax should be applied to the roads only, and it should not be directed to schools, orphanages, charity, and other worthy uses as has been urged in some cases and, according to information, is being done.

Grade crossings must be separated and where to get the money is the question. It is a fact that one grade crossing has cost as high as $200,000 and New York State has already expended in excess of $30,000,000 to separate only a small fraction of its crossings. Some of the money is suspected of being diverted to grafters in sections and that creates a problem for the tax payer. It is not what you pay but what you get that causes taxes to be burdensome. Don't complain about the Gas Tax or any tax, but pay it and see that you get the worth of your money, is the duty of every citizen.

One Victory Plant Soon to Operate

The first of two plants to be operated by the Victory Sand and Stone Company will be in operation within 60 days, according to a statement by John Loveridge, vice-president and general manager. The company, with a capital stock of $100,000 has been granted a charter by the state of Arkansas. The first plant will be at the foot of Harrison street; the second along the Rock Island tracks. The company also will establish a rock plant west of Topeka. Sand, gravel and stone will be furnished for building and road work.

Incorporators are Paul Sherman, of Topeka, president; John Loveridge, of Chicago, who will move to Topeka immediately, vice-president and general manager; W. E. Francis, of Topeka, secretary-treasurer; M. C. Sherman, Topeka, L. A. Capsey, Kansas City, Missouri. Harry Colmery will be the attorney. Paul Sherman, the president, has been employed by the Santa Fe in Topeka for 24 years. He has been in the engineering department, and part of the time in charge of a subsidiary company in New Mexico.

Recent Patents

The following patents of interest to readers of this journal recently were issued from the United States Patent Office. Copies thereof may be obtained from R. E. Burnham, patent and trade-mark attorney, Continental Trust Building, Washington, D. C., at the rate of 20c each. State number of patent and name of inventor when ordering.

1,649,565. Hammer crusher. George W. Borton, New Lisbon, and William A. Battey, Haverford, Pa., assignors to Pennsylvania Crusher Co., New York, N. Y.

1,649,739. Power shovel. George T. Rosselle, Muskegon, Mich., assignor to Austin Machinery Corporation, same place.

1,649,813. Grinding cement material, etc. Edward C. Dalgaard, Copenhagen, Denmark, assignor to F. L. Smidth & Co., New York, N. Y.

1,649,883. Vibrating screen. Herbert S. Woodward, Carbondale, Pa.

1,650,027. Mining and loading machine. Edmund C. Morgan, New York, N. Y., assignor to American Morgan Co., same place.

1,650,255. Mechanical shovel. Alfred E. Banister, Duluth, Minn.

1,650,566. Mining-machine chain. Frank L. Fulke, Terre Haute, Ind.

1,650,578. Mining-machine. Charles W. Wyman, Claremont, N. H., assignor to Sullivan Machinery Co., same place.

1,650,592. Concrete-mixer. Ackert Bickel, Kansas City, Mo.

1,651,192. Switch for mine railroads. Henry W. Davis, Rock Springs, Wyo.

1,651,372. Pulverizing and separating machinery. John C. Carline, Hull, England.

1,651,555. Gravel-screen and cleaning device therefore. Carl Sandberg, Battle Creek, Mich.

1,652,151. Charge-synchronizing means for concrete-mixers. Emil L. Tranaas, Milwaukee, Wis., assignor to Koehring Co., same place.

1,652,240. Combined clutch and drum and mounting therefor. Earl H. Fundom, Lima, Ohio, assignor to Fundom Hoist & Shovel Co., same place.

1,652,434. Concrete-laying machine. Abram N. George, South Pasadena, and Vincent Bressi, Oceanside, Cal.

1,652,588. Sand cutting and piling machine. Harry Smith, Chicago, Ill., assignor to American Foundry Equipment Co., New York, N. Y.

Lutesville Building New Plant in Arkansas

The Lutesville Sand and Gravel Company is building a new plant at Spring River about a mile above Black Rock, Arkansas. The Arkansas-Missouri Power Company will immediately start the erection of a power supply line, since electric as well as steam power will be used. The plant will require about four months to be placed in operation.

United Talc Rebuilds

The United Talc and Crayon Company, Inc., of Glendon, North Carolina, have started to rebuild their plant which was destroyed by fire. The new plant is expected to be completed and in operation by the middle of February.

NEWS OF EQUIPMENT MANUFACTURERS

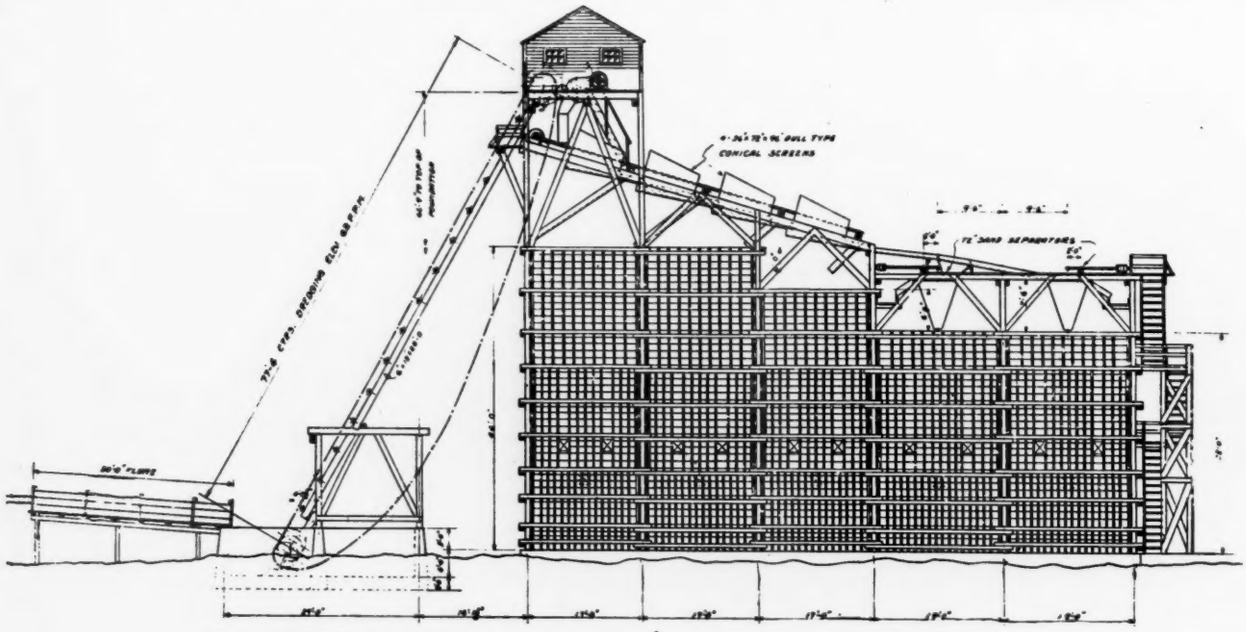


Fig. 1. Typical Installation of Gravel Washing Plant Using Digging Elevator.

Link-Belt Digging Excavators

By C. S. Huntington

For the past few years an increasing number of plants have been using dredge pumps for excavating sand and gravel, particularly where the deposit does not contain many large rocks. The pump has been used to force the material through the pipe line to the washing screens at the top of the plant.

A centrifugal pump can force material in a horizontal pipe with a fair degree of efficiency, but consumes a great deal of power in elevating material over a few feet. This can be explained quite easily. A pump will handle on the average about 10 per cent of solids and about 90 per cent of water. The average screening plant is about 60 feet above the foundation. A pump must lift this extra 90 per cent of water to get the 10 per cent of solids this entire height. This consumes a large amount of power.

To avoid this, Link-Belt Company has developed a plan of letting the pipe discharge into a concrete sump at ground level. A special elevator is placed in this sump in such a position as to dig out the sand and gravel with very little water, and elevate it to the top of the plant. The surplus water received flows out at the discharge spout of the sump. Figure one shows an outline of a typical installation.

The head sprockets are made of cast steel, with renewable, reversible manganese steel teeth. The foot wheels are seven-sided, single-flanged, cast-steel wheels. These wheels are operated under water, and are designed in such a way that the chain will not jump from the wheel in case a large stone gets between the chain and the wheel. High side

Two Special 18 by 12 by 30 Inch Digging Elevators Using Manganese Chain at Forreston, Ill.

flanges take care of the slack in the return run of chains.

The buckets are of the continuous type, and are equipped with manganese lips. The chain is made of steel throughout. The inside links have a boss on one side which extends to the center line of the chain. A manganese steel collar is placed around the boss. The pin is of manganese steel, with an "L" head. This head fits in the outside link, which keeps the pin from turning.

The elevator travels up the incline on single flange idlers fastened to the supporting frame work. The return run hangs free from the head shaft.

In existing plants using belt conveyors, the elevator buckets may be perforated, allowing the water in the buckets to drain back into the sump, and permitting the discharge of fairly dry material onto the belt conveyor.

In such cases an elevator of shorter centers may be used. Proper drainage can be obtained with about thirty-five foot centers.

Plants now operating with dry pits, but having sufficient material below water, may, by the addition of a dredge pump and digging elevator, excavate that part of the pit below water and put the material through the present washing and screening plant.

Foot of Elevator at Plant of Valley Sand and Gravel Company, Wadsworth, N. Y.

Clam Shell Buckets

The Haiss "Contractor" type Clam Shell Bucket has been redesigned to incorporate the extending arm brackets on the back of the bowl, these brackets now being placed in the back instead of inside as heretofore. The lugs taking the arms to the headpiece have been extended to get more digging power increasing the leverage from the center pin to the back arm about 4 inches on each side or a total of 8 inches.

The wheel on the bucket has been redesigned and careful attention given to the lubrication of this wheel and the center shaft. The wheels are bushed with bronze bushings 6 inches long equipped with Alemite fittings in the center. These wheels are steel and will last for the life of the bucket. The rope guards have been redesigned, the cross guards being connected to the inside arm instead of to the bowl as heretofore.

A new headpiece (patent pending), incorporating the lugs that extend beyond the center shaft bolted to the inside connecting rods, make the arms stiff and rigid and prevent any shimmying in the head. All the pins and bushings have been increased in size to take advantage of the greater digging action.

Centrifugal Pumps Double Suction—Single Stage

Bulletin number 209 has just been received from the Pennsylvania Pump and Compressor Company, which describes its double suction, single stage centrifugal pumps, including diagrams to show the characteristic curves of the pump and for determining the friction of water flowing from the pipes. It also contains valuable illustrations showing a typical pump installation and the correct methods of suction piping.

Centrifugal pumps, described, are built in two sizes of casings known as MD and HD which adapts them to the different speeds of prime movers and the pumps are built in sizes to handle capacities to 20,000 g.p.m. and heads up to 290 feet. Sturdiness and simplicity are combined with a number of new features which have contributed to reliability and high efficiency.

Among the special features of the pump is a patented balancing port, connecting the two suction chambers at impeller inlet. Difference in pressure at these points will cause a flow through the port, equalizing the pressure and eliminating end thrust and the necessity for thrust bearings. The impeller shaft is made from high carbon steel, oil tempered and annealed. Replaceable wearing rings are fitted at the joint between the impeller and casing so that all wear or erosion may be corrected at any time. Large stuffing boxes, identical at both ends are used, which makes for duplication of packing, sealing cages and glands. The bearing bushings are the double ring oiling type and are self-aligning on account of the spherical seat. The rubber-buffer type flexible coupling is mounted on the impeller on a taper fit, keyed with two Woodruff keys and held securely in place by top bolt and washer. A laboratory is maintained for accurately testing centrifugal pumps as the horse power is measured by torsion dynamometers, the capacity by weirs and the pressures are determined by calibrated gauges.

Mundy Appoints

The Mundy Sales Corporation announces the appointment of the Smith Booth Usher Company as exclusive distributors for the Mundy Sales Corporation for the complete line of equipment built by the Mundy Hoisting Engine Company and the line of derricks and fittings built by the Dobbie Foundry and Machine Company, for the states of California, Nevada and Arizona.

New "Switch Start" Motor

A new "Switch Start" motor for which several advantages are claimed, and which is built by The Lincoln Electric Company in sizes from ½ to 30 h.p. and for either 2 or 3 phase, 60 cycle current, has been announced. This motor is so designed that it can be started directly across the line without the use of a starting compensator, starting resistance or other voltage reducing mechanism, with starting current below the requirements of the National Electric Light Association.

The chief claim for the "Switch Start" motor is that operating characteristics, such as power factor, efficiency, maximum torque, temperature rise, etc. have not been sacrificed in order to secure low starting currents. Equal or better efficiency and power factor from 5 to 10 points higher than the ordinary self start motor are claimed. Tests show that starting torques of from full load to better than 250 per cent of full load, depending on the horsepower and speed, are possible without exceeding the N. E. L. A. requirements.

Comparison of the speed torque curves of these motors with the ordinary self start motors show that the "Switch Start" motor has equal or slightly higher actual torque at zero speed. The curve then shows a gradually increasing torque up to the maximum torque point, whereas curves of the ordinary self start motor decrease sharply to a low point which is only a small percentage over the full load torque point and then increases to the maximum torque point. This gradually increasing torque of the "Switch Start" motor is highly desirable for starting many types of machinery.

On sudden high overloads it is claimed that the "Switch Start" motor also has a very high or maximum pull or torque which is of considerable importance in that this motor will not stall on sudden high overloads. This feature is in marked contrast to many self start motors where the operating characteristics have been sacrificed for starting characteristics.

It is claimed the temperature rise of the "Switch Start" motors under continuous full load has been found to be quite low, giving a cool running and long life characteristics, due to the electrical design and also to the welded steel construction which is characteristic of all "Linc-Weld" motors and which permit a greater circulation of air.

Paver, Shovel and Mixer at Road Show

Koehring Company will exhibit at the Road Show in Cleveland, January 9 to 13, its 27E paver, number 501 shovel, 10S Dandie Mixer and subgrade planer. The Koehring space is number 48 in the West Wing of the Auditorium.

A particularly interesting feature of the 27E Heavy Duty Paver is a built-in calcium chloride attachment. In addition there are several refinements which will be seen on this machine. One of these is in the water control, where the indicator has been placed near to the tank and directly connected to the measuring pipe inside. A butterfly valve has been placed in the inlet pipe to the drum to assure constant delivery of water during a specified length of time.

An improved derrick with vertical 6352 Pit & Quarry 12-29 Madigan operating lever and quick-acting brake, replaceable wearing plates in the skip and boom bucket, and a clothes locker built on the operator's platform are among the improvements to be shown on the Koehring 27E Paver at the Road Show.

With its 27E Paver the Koehring Company will also have its Subgrade Planer, a valuable tool which has come into general use in concrete paving work during the last few years.

The Koehring 501 Shovel will be shown with a 1¼ yard dipper and 16 ft. dipper sticks. Depending upon the kind of work for which the machine is to be used, two other sizes of dipper may be had—a 1½ yard dipper on 14 ft. dipper sticks or a 1 yard dipper on 19 ft. dipper sticks.

A power dipper trip, cast steel carbody, multiplane girders and side frames, ball bearing-mounted high speed shafts, and roller bearing-mounted vertical traction and swing shafts are other Heavy Duty features which the shovel buyer will find on the Koehring.

The 10S Dandie Mixer, with one-man control at drum end of mixer, will complete the exhibit. This two-bagger (1-2½-4) is light in weight but characteristically sturdy in construction, with quiet worm drive direct power transmission. It has an unusually short turning radius—it being possible to turn the mixer completely in any street. The 10S Dandie weighs, complete, less than 4,875 pounds.

Radiators at Road Show

For seventeen years Perfex Corporation has exhibited under the name Racine Radcliffe Radiator Company, which was changed to conform to that of the trade marked product Perfex Radiators and was changed when it moved into the new larger plant at Milwaukee.

Perfex will exhibit in space EH-38 a full line of heavy-duty engine cooling radiators designed for farm tractor, motor truck and industrial service. Three types of radiators will be shown, sheet metal tank, cast tank and sectional cove. The latter was designed for large Diesel engine installations and for oil field service. Also two types of coves will be exhibited, the tubular and fin type and the Perfex patented cellular type. Also a new cove developed for cement mixer service will be shown. This is unique because of its large air passages which do not easily clog up with cement dust and if dirty can be easily cleaned out, thus restoring the efficiency of the radiator. The company will be represented this year for the fifth time by Roger Birdsell, sales manager, R. W. Wilson, H. L. Zimmerman and A. C. Owen.

Biasbrix Tested

One of the most difficult problems of fire brick construction, in the opinion of a great many engineers, is the difficulty of making brick stay put under the stress and strain of actual working conditions. There is always the tendency for walls to loosen up and joints to open, resulting in heat losses, slag penetration and eventual disintegration. This problem of a stronger wall is said by the General Refractories Company to have been solved by its development of Biasbrix, a unique shaped refractory. As the name implies, Biasbrix are laid up on the bias, one brick overlapping and tying together three other Biasbrix in a natural, self-locking construction which gives exceptionally tight joints and a wall of great strength. Owing to this peculiar construction and interlocking feature, walls laid of Biasbrix do not loosen up, joints remain tight and heat losses and slag penetration are reduced to the minimum.

Although different in shape, Biasbrix lay up as readily as the ordinary straight brick in any thickness of wall from 4½ inches to 27 inches or more, and are equally well adapted to large or small installations.

Hoppers at Road Show

The Butler Bin Company will exhibit at the Cleveland Road Show in space WW-42, a full size V-20 cubic yard, two compartment bin equipped with a set of the latest type Butler Weighing Hoppers. It will have on exhibit a set of Type A Standard Measuring Hoppers and a miniature working model of a Type V-40 cubic yard two compartment bin complete with a set of measuring hoppers. In connection with this exhibit, it will show moving pictures.

Making Hume Concrete Pipe

The manufacture of reinforced concrete pipe provides an excellent outlet for surplus materials to sand, gravel and crushed stone producers. In addition to absorbing surplus material, the manufacture of reinforced concrete pipe is a profitable business in itself or as a side line.

The American Hume Concrete Pipe Company offers the necessary equipment for manufacturing concrete pipe by centrifugal force. This pipe is known as the Hume Concrete Pipe.

In spinning the pipe the centrifugal force packs the concrete in an even, dense wall on the inside of the form and when the spinning action is completed all of the excess air and water has been squeezed to the inner surface of the pipe carrying with it any silt or other deleterious matter which may have been included in the materials incorporated in the concrete.

When the spinning action ceases, this excess water flows out of the ends of the finished pipe in the form of a slurry, leaving in the wall of the pipe only clean, dense concrete.

The reinforcing steel for Hume Pipe is made up in circular cages of exact diameter, and the centrifugal force of the spinning action places this steel perfectly concentric with the axis of the pipe.

This process of making Hume Reinforced Concrete Pipe is very simple. First the wire reinforcement is made up into cages of exact diameter by either using a fabricated wire mesh or by winding wire on a collapsible drum in a spiral fashion, the spiral being held in place by longitudinal wires. The reinforcement, varying in weight and strength according to the pressure or external load the pipe is designed to carry, is placed in the steel mold. Flanges or end rings, cast to form the bell and spigot ends of the pipe, are attached to the ends of the mold. These rings are of a depth equal to the desired thickness of the wall of the pipe.

The mold is then laid horizontally on a machine consisting of friction rollers which set the mold revolving. While the mold is turning at a low speed the amount of concrete necessary for the pipe is inserted. The centrifugal force of the spinning action causes this concrete to distribute itself evenly over the inner surface of the mold completely embedding the reinforcement.

The speed is then increased. After spinning for a few minutes the mold is brought to rest, and the excess water, which by the action of the centrifugal force has been expelled from the concrete, is allowed to run off. The machine is then restarted and the pipe once more spun for about two minutes. During this final process the inside of the pipe is burnished by passing a steel bar over the surface. The mold containing the pipe is then taken from the machine and rolled into the curing chamber where it is cured in wet steam at a temperature of approximately 100 degrees Fahr. for seven to twelve hours.

The pipe are steam cured in order to secure the hardening of the concrete under the best conditions. The warmth of the steaming chamber hastens the hardening of the concrete while the moisture in the steam prevents any tendency of the concrete to dry out or crumble. It has been definitely proven that concrete of the greatest strength is obtained by curing under warm, moist conditions and the steaming process provides both of these conditions.

Byers Purchases Massillon

An announcement of particular interest to the non-metallic mineral industries is the purchase of the Massillon Power Shovel Company by the Byers Machine Company, Ravenna, Ohio. This differs somewhat from other mergers and consolidations that have taken place in this field, in that the Byers company is buying the Massillon stock and taking over the entire responsibility of distribution and sales of Massillon shovels along with the Byers Bear Cat line.

Important economies in manufacturing and in selling will be effected, to the advantage of both companies, and the combined organization will be an unusually strong one, both in engineering and in executive personnel.

The principal reason advanced for the purchase, and one of particular importance to the distributing organization, is to provide a complete line of shovels and cranes, from ½ yard to 1¼ yard capacity. Byers Bear Cat is well known as an all purpose machine of ½ yard capacity, its popularity proving so great when it was put on the market a few years ago that Byers discontinued the other lines which it had been making for years and concentrated on this one model. The Bear Cat is now offered in both half-revolving and full-revolving types, ½ and ⅝ yard capacity.

The Massillon "35" gas shovel is a comparatively recent development in the field of 1 and 1¼ yard machines which has attracted a great deal of interest, due to the claims that it exceeds steam shovels as well as other gas shovels in speed and flexibility. The machine is of advanced design, with centralized power, and has a Hercules engine of unusually high power for the machine's capacity. It has a rope crowd, of a design that permits great flexibility in crowding and shaking, and yet without being destructive on the cable. In addition to the shovel, the machine is designed to handle clamshell, dragline, and trench hoe.

The completeness of the line now offered by Byers under the new arrangement is further emphasized in the fact that Massillon is also making steam shovels, for which there is still considerable demand, and in the design of which the Massillon engineers first attracted favorable attention.

The present manufacturing plants of both companies will be continued, Massillon shovels being manufactured as before at the Massillon, Ohio plant, under the direction of Mr. E. H. Birney, president of the Massillon Power Shovel Company.

New Welder

A new single operator welder rated 300 amperes, one hour, 50 degrees C. temperature rise is announced by the General Electric Company as the latest addition to its standard line of welding equipment. This machine includes a four-bearing, ball-bearing, motor-generator set with flexible coupling.

With this equipment the manufacturers claim a rapid and simple interchange of motors may be made by the user. As a result inspection, maintenance, renewals and changes caused by changes in the supply circuit would be simplified.

The generator is rated 300 amperes, one hour, 50 degrees C., and the driving motor is a 15-horsepower, 40 degree C., continuous-rated unit. This confirms with the recent ruling of the National Electric Manufacturers Association. The generator is so designed that field control is unnecessary and is eliminated. The generator panel includes an ammeter and a voltmeter, but not the customary field rheostat. The meters used have a metal front except for the glass over the scale, thus minimizing the possibility of breakage.

The motor starters for 60, 50 and 25 cycle motors are of the enclosed magnetic type. The direct-current motors use a simple resistance starter with a line switch. Starting current is maintained in each case well within N. E. L. A. requirements. The generator is designed to permit belt, motor or engine drive, and will be designed for either stationary or portable use.

Rates for display advertisements in the Broadcast Section are given below. If you want to buy or sell used equipment, if you want a job or need a man, advertise your wants in Pit and Quarry. Advertisement copy for publication in the next issue should reach our office within one week after the date of this issue.

RATES PER INSERTION	1 Inch	2 Inches	3 Inches	4 Inches	5 Inches	6 Inches	8 Inches	9 Inches	10 Inches	12 Inches	15 Inches	20 Inches	30 Inches
1 Insertion	$3.75	$7.25	$10.75	$14.25	$17.75	$21.25	$28.25	$31.75	$35.25	$42.25	$56.25	$70.25	$105.00
2 Insertions	3.75	7.25	10.70	14.20	17.65	21.15	28.15	31.65	35.15	42.15	56.15	70.00	104.00
3 Insertions	3.75	7.20	10.65	14.15	17.55	21.05	28.05	31.55	35.10	42.05	56.05	69.75	103.00
4 Insertions	3.70	7.15	10.60	14.10	17.45	20.95	27.95	31.45	35.00	41.95	55.90	68.75	102.00
8 Insertions	3.65	7.05	10.50	14.00	17.25	20.75	27.75	31.25	34.80	41.75	55.70	67.50	98.00
13 Insertions	3.60	6.95	10.40	13.90	17.05	20.55	27.55	31.05	34.60	41.55	55.55	66.25	94.00
26 Insertions	3.50	6.75	10.20	13.70	16.65	20.05	27.05	30.65	34.20	41.05	55.05	64.00	88.00

INFORMATION—*"Broadcast"* space is sold by the advertising "inch." Each page contains 30 inches. The width of the page is divided into 3 columns, each 2¼ inches wide. Each column contains 10 inches measured the length of the column. Any space may be used measured by the *even* inch in height (not fractions), by 1, 2 or 3 columns in width. The size of a space is its height in inches multiplied by the number of columns in width. Example: a space 3 inches high by 2 columns wide is 6 inches. Copy changes made without additional charge.

It Pays to Advertise in PIT and QUARRY

The Cowham Engineering Co., Chicago, Ill., inserted a "wanted" advertisement for a quarry superintendent in the October issues, and under date of December 1, 1927, they wrote: *"Results satisfactory."*

Complete Service Publishing Company

538 South Clark Street **CHICAGO**

Machinery for Sale

SPECIALS
Two No. 6 Williams Universal Hammer Mills.
Two 6' Hardinge Mills and One 4½' Hardinge Mill.

CRUSHERS
Crushing Rolls
One new 42"x16".
One 8"x5", two 16"x10", two 24"x12", one 30"x10".
Two 26"x15", one 30"x16", two 36"x16", one 54"x24".

Gyratory
All sizes from No. 2 Reduction to No. 12K.

Jaw
One 4"x8"—two 7"x10"—one 6"x20"—two 9"x15"—one 10"x20"—two 12"x24"—one 13"x30"—one 18"x36"—one 24"x36"—one 40"x42"—One 60"x84".

Rotary
Two No. 0, two No. 1, one No. 1½, and one No. 2 Sturtevant Rotary Fine Crushers.

Ring Roll
Two—No. 0, two—No. 1 and one No. 2 Duplex Sturtevant ring roll mills.

Ball and Tube Mills
3', 4', 4½', 5', 5½', 6', 8' Hardinge Mills and Tube Mills.

DRYERS
Two 3'x20', Three 4'x30', One 4½'x30', One 5'x40', Three 5½'x40', Two 6'x60', One 7'x60' and One 8'x80' Direct Heat Rotary Dryers. One 5'x25', one 6'x30'. Two 8'x80' Ruggles Coles type "A" and One 4'x20' Ruggles Coles type "B" Double Shell Rotary Dryers.

KILNS
4'x40', 5'x60', 6'x60', 6'x70., 6'x90', 6'x100', 6'x120', 7'x80', 8'x125'.

MILLS
Two 33" and two 42" Fuller Lehigh Mills.
One No. 0000, and two No. 1, one 2-roll, and two 4-roll.
Swing Hammer Mills, Griffin Mills, Attrition and Cage Mills.
Air separators, Screens, Elevators and Conveyors.

The Heineken Engineering Corp.
Industrial Engineers
95 Liberty St., New York City
Hanover 2450

LOCOMOTIVES
1—56-ton 6-wheel Standard gauge Saddle Tank, new A.S.M.E. boiler, electric head lights, oil burning equipment.

LOCOMOTIVE CRANES
1—30-ton Ohio 8 wheel, double power drums, 50-ft. boom outriggers, factory rebuilt.
1—22½-ton Ohio 8 wheel, double power drums, 50-ft. boom, factory rebuilt.

CATERPILLAR SHOVELS
1—68C Bucyrus electrically operated shovel on caterpillars.
1—20B Bucyrus Steam Shovel on caterpillars.

Morris Engineering Co.
Phone: Cortland 0604
30 Church St., New York

BARGAINS
In Stone Crushing Machinery
1—Set Sturtevant Balanced Rolls, 21"x11".
1—Kite Jaw Crusher, 7"x16".
1—Sturtevant Jaw Crusher, 8"x10".
1—Williams No. 2 Hammer Mill.
1—Sturtevant No. 2 Rotary Crusher.
1—Champion Jaw Crusher, 9"x15".
1—Jeffrey Type A Hammer Mill, 30"x24".
1—Allis Chalmers Roll Crusher, 24"x14".
3—6"x4" Bucket Elevators, 30' centers.
1—Sturtevant 3-Tier Moto Vibro Screen. Type MV, with screw feed.
1—3'x6' Trommel Screen.
1—100 H.P. Locomotive Type Boiler, 100-lb. pressure.
1—3½'x20' Direct Heat Rotary Dryer.
1—4'x20' American Process Dryer.
1—5'6"x40' Direct Heat Rotary Dryer.

WE BUY YOUR SURPLUS EQUIPMENT

CONSOLIDATED PRODUCTS CO., INC.
15 Park Row, N. Y. C., Barclay 0603

CRAWLER SHOVELS
2—ERIE DREADNAUGHT; Steam, 1-yd., HIGH LIFT; New 1926; One with 40 ft. Crane Boom if desired.
2—ERIE GAS & AIR; 1-yd., HIGH LIFT; New May 1927; like new.
1—KOEHRING; GASOLINE; New late 1926; 1-yd., HIGH LIFT; Like new.
2—THEW, TYPE O; GASOLINE; ¾-yd., HIGH LIFT; New 1926; Overhauled Nov. 1927; Guaranteed like new.

CRANES
1—30-ton, 8-wheel, BROWNING No. 3 Locomotive Crane, New 1921; A.S.M.E. & Mass. Boiler; 50 ft. & 70 ft. Boom; Bucket operating.
1—12-ton cap. NORTHWEST, No. 105; GASOLINE Caterpillar Crane, New Aug. 1926; 40 ft. Boom; Like new.
1—10-ton cap. P.&H. Model No. 206; GASOLINE Caterpillar Crane, New late 1926; 40 ft. Boom; Steel Cab; Excellent condition.
1—10-ton cap. BROWN HOIST No. 2; GASOLINE, Caterpillar Crane, New 1924; 40 ft. Boom; ¾-yd. C. S. Bucket; Overhauled Nov. 1927.

DUMP CARS
30-yd., 20-yd., 16-yd. & 12-yd., Std. Gauge, ALL-STEEL, Latest Type Automatic Air Dump Cars; Practically new.

Grey Steel Products Company
111 Broadway New York, N. Y.

FOR SALE OR RENT

DUMP CARS
5—12-yd. Western, Std. Ga., Air. Perfect Condition.

GASOLINE SHOVELS AND CRANES
1—Link-Belt Comb. Gas-Crawler, 1-yd. Shovel and 15-ton, 50 foot boom Crane. Like new.
1—Northwest, Model 105, 50' Boom. 2-yrs-old.

STEAM SHOVELS
1—McMyler ¾-yd. Cat. Steam; also 40' Crane Boom. New 1927.
1—Marion, Model 32, 1¼-yd. Dipper, Full Cat., High Lift, Rebuilt 1927. Perfect shape.

GASOLINE LOCOMOTIVES
2—7-ton Plymouth, 36" Gauge. Like new.
1—8-ton Plymouth, 36" Gauge. Like new.

HOISTING ENGINES
1—40 HP. Mundy, DD, 2-ph., 60-cyc., 220-v.
1—22 HP. Lambert, DD, 2-ph., 60-cyc., 220-v.
1—7x10 Lidgerwood, DC, DD, Boiler mounted with Swinger attached.

BOILERS
1—125 HP. Locomotive Type, ASME, 125 lb. Pressure.

TRACTORS
1—10-ton Holt, Gas. Cat.
1—2-ton Holt, Gas. Cat.
1—5-ton Holt, Gas. Cat.

B. M. WEISS
1324 Widener Bldg., Philadelphia, Pa.